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Errata

Page 17, line 3 from bottom, for "*Marsilia*" read "*Marsilea.*"
Page 70, line 6, for "*leicocarpa*" read "*leiocarpa.*"
Page 68, line 11 from bottom, for "*neomexiana*" read "*neomexicana.*"
Page 70, line 17, for "*Maximiiliani*" read "*Maximiliani.*"
Page 95, line 2 from bottom, for "60" read "61."
Page 114, line 4, for "*terebinthinaceus*" read "*terebinthinacea.*"
Page 135, headline, for "*Oenoethra*" read "*Oenothera.*"
Page 167, line 17, for "Linn" read "Lane."
Page 168, line 19 from bottom, for "*Lipinus*" read "*Lupinus.*"
Page 201, line 6, for "*Marsilia*" read "*Marsilea.*"
Page 211, line 18, for "*Dobinia*" read "*Dobinea.*"
Page 213, line 1, for "a late" read "alate."
Page 269, line 21, for "*A. gaviotus*" read "*H. gaviotus.*"
Page 270, line 4, for "*S. filipes*" read "*H. filipes.*"
Page 270, line 11, for "*Nivius,*" read "*Nevius.*"
Page 271, line 6, for "CONOVIRENS" read "CANOVIRENS."
Page 278, line 1, for "517, 559" read "517.559."
Page 290, line 16 from bottom, for "*Stenolepsis*" read "*Stenolepia*" and for "*Nephrolepsis*" read "*Nephrolepis.*"
Page 292, in legend under figure, for "*imbricatus*" read "*imbricata*"
Page 344, lines 15 and 17 from bottom, for "f". read "s".

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OF THE
TORREY BOTANICAL CLUB

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Vol. 50 No. 1

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OF THE

TORREY BOTANICAL CLUB

JANUARY, 1923

The histology of certain orchids with reference to mucilage secretion and crystal formation

EDNA L. SMITH

(WITH PLATE 1)

The subject of mucilage secretion in plants is one which has been discussed from several points of view. The relation of the mucilage to growth, to the prevention of loss of water by transpiration, its possible rôle as reserve food material, its chemical composition, its origin, the processes in connection with its formation; all are questions as to plant slimes which are still disputed. The relation of raphides to cell mucilage is undetermined, although it has long been noted (Frank, Stahl, Walliczek, Tschirch and others) that mucilage occurs in cells which bear raphides.

Frank (1867) distinguished plant slimes as gums and mucilages and recognized three general types. First, those from the protoplast; second, those deposited by the cell wall; and third, those which occur in intercellular canals. He described the mucilage in several species of orchids as being derived from the protoplast, since, as he observed, there is invariably a thin layer of cytoplasm and the nucleus between the mucilage and the cell wall. Frank also observed the association of raphides and mucilage in the cells of orchids.

Stahl (1888) considered slime in crystal-bearing cells as a reserve food supply, a protection against being eaten by animals, and a water regulator. The matter of its origin he does not attempt to settle.

[The BULLETIN for December (49: 349–407) was issued January 27, 1923.]

F. P.

Gardner and Ito (1888) believe that the mucilage in the fern hairs of *Blechnum occidentalis* and *Osmunda regalis* is a product of the cell contents and that it is secreted as drops in the cytoplasm until the protoplast is exhausted, only a thin layer of the cytoplasm remaining.

Groom (1893) notes in a discussion of bud protection in dicotyledons: "The employment of a hygroscopic substance like mucilage is an admirable means of controlling the water supply of an organ for two reasons; first, the osmotic power of a solution increases with the concentration of the solution. Therefore, when the bud is in the greatest danger of losing all the water; when the temperature is high and a considerable amount of water has been evaporated from the mucilage, the remaining water is held most firmly, and a supply of water is absorbed most fiercely." He ignores the relation of the colloidal character of the mucilage to the imbibition of water. Were the principle of osmosis the only one involved here, the cells of the young buds would need to be vacuolated, as mucilage cells are predominantly reported not to be.

Tschirch (1889 and 1908) distinguishes between cellulose slime and true slime and gums. He further differentiates them under the headings: epidermal slime (*Cydonia*, *Salvia* and *Linum* seeds), slime of the outer wall (alga and fungous mycelium slimes), slime of the intercellular spaces (*Tilia*, Malvaceae, *Laminaria*), cell content slime (*Orchis* tubers), schizogenous excretions (cycads, *Aralia*, *Laminaria*), and lysigenous excretions (*Acacia*, *Prunus*, *Sterculia*). In some cases he found empty slime cells which he took as an indication that the contents had been taken up again in the metabolism. The resins, he says, originate in a special layer of the wall, to which the material for making resin is brought, and calls this the resinogenous layer.

Walliczek (1893) distinguishes gums, epidermis slime, cell membrane slime, and cell content slime. Of this last type of mucilage in connection with the Polygonaceae he says that he found slime in cells bearing raphides whose development here as in the case of all other such slimes is not certainly known. The forms which he studied did not contain such slime, so he has left this question as he found it. He confines his research to the slime in the vegetative organs, especially the epidermal cells of the leaves and the inner tissues of the vegetative organs,

since he considers that the epidermal slime of seeds and endosperm slime has been shown to originate from the secondary thickening of the cell wall. He recognizes four types of epidermal slimes, as follows:

1. The inner wall thickened by a secondary slime membrane (*Althea rosea*, *Quercus pedunculata*, *Malva vulgaris*, *Cornus mas*).

2. The inner wall thickened by a secondary slime membrane and upon this a tertiary cellulose lamella (several species of *Cassia*, *Ulmus glutinosa*, *Corylus Avellana*, *Arbutus unedo* are a few examples). This type is the most common of the four.

3. The inner and outer walls thickened by a secondary slime membrane and upon this a tertiary cellulose lamella, the side walls also thickened (*Salix alba* the only example of this type known to Walliczek).

4. The lower cell wall thickened by a secondary slime membrane and a tertiary cellulose membrane, a quaternary slime membrane, a fifth cellulose membrane and so forth up to ten layers which was the largest number observed (*Barosma vulgaris*, *B. crenulata*, *B. serratifolia*, *B. crenata*, and *B. betulina*).

In all cases the slime membranes give the reactions of what Walliczek calls true slime from their first occurrence. These reactions are swelling in water, precipitation by alcohol, and not staining blue with iodine and sulphuric acid. Cellulose slimes are described by him as staining blue or violet with these reagents. Only the mucilage of the seed epidermis of crucifers, of *Cydonia* and of *Salvia* have been proved to be of this sort.

Walliczek in considering the slime membranes in the inner tissue of vegetative organs notes that with certain treatments plant slimes which are to be regarded as arising in the form of secondary thickenings show stratification, and that this stratification is the best morphological distinction between cell membrane slime and cell content slime. The latter appears quite homogeneous ("*Orchis*-Schleim","Raphiden-Schleim"). He notes, however, that proof of the origin of cell content slime is certain only in *Symphytum* and *Orchis*. There may be also cell membrane slimes which do not show stratification. Walliczek cites the slime of *Tilia grandiflora* as an illustration, though it is generally classed as a cell membrane slime. In the later stages at least he notes also that all slimes may be more or less dissolved and that in the stages of solution the stratification disappears.

Walliczek studied the slimes of the inner vegetative tissue of *Tilia grandiflora*, *Tilia parviflora*, *Hibiscus syriacus*, *Theobroma Cacao*, *Althaea taurinensis*, *Rhamnus Frangula*, and the following, cacti: *Epiphyllum*, *Echinopsis Eyriesii*, *E. multiplex*, *Mammillaria densa*, and *Opuntia Tuna*. In no case does he consider these as cell content slimes, although in discussing the slime of cacti he says that the mucilage is laid down upon the primary wall as a secondary thickening, but that the primary wall has no active part in the process, and that the cytoplasm, as the laboratory of the cell, is in each case (species of *Epiphyllum*) the builder of the deposits of slime, which are, however, never found within the primordial utricle but always outside it.

He describes the stages in the development of the mucilage cells in *Tilia grandiflora*, these including the enlargement of the cells and the increase in density and amount of the cytoplasm and nucleus. By the deposit of mucilage these are pushed to the center of the cell and finally in the mature cell have the appearance of undergoing disintegration. He says the slime is laid down centripetally, that when it dissolves the inner part disappears first, and that during their development neither the slime cells nor those surrounding them contain chloroplasts or starch. The process of mucilage formation is a very quick one. Later the mucilage begins to dissolve and the dissolved slime seems to be changed into starch. At least the slime cells of the cortex in *Tilia grandiflora*, which show stages of mucilaginous disintegration, are densely filled with starch, as are also the neighboring cells and no others. He has studied the history of the slime cells in this species with reference to their changes with age and concludes that noticeable changes may not occur until the third year, when the slime cells may show only traces of stratification on the primary cell wall. In other cells the disappearance of slime was much longer delayed and he found eight year old slime cells which were little changed in appearance from newly formed ones, though his general conclusion is that in all cases the slime of the inner tissue is at least in part dissolved and taken up in the metabolism.

In the case of *Scilla maritima*, *Symphytum officinale* and *Orchis* tubers he thinks without doubt that the slime is a store of reserve food (Tschirch). The function of slimes in general he thinks is that of storing water which can be distributed to the surrounding tissue in time of need.

Schilling's view (1894) as to the function of slime cells in water plants was that they are water regulators for the young parts without a protective epidermis, which disappear as soon as the outer tissue has developed.

Kohl (1899) has given an extensive account of raphides and their relations to plant slimes. In summary he finds that they consist of calcium oxalate; that they belong to the monoclinic system (though they are in many cases impossible for a crystallographer to define because of the smallness of the needles, their large angles and the curvature of the crystal face); that they appear very early in the development of the organ in which they occur, having been observed one millimeter from the growing point; that the number of cells containing them increases with the unfolding of the plant part; and that as soon as the cell bearing them has reached its typical form it remains relatively unchanged during its whole subsequent existence. Kohl notes that in the course of his observations he has never found that the raphides disappear. He describes their development as follows: they originate in vacuoles singly or in numbers, each crystal being ensheathed in a plasma membrane, and the mature bundles being bound together in a cytoplasmic sheath attached to the primordial utricle by cytoplasmic strands. The nucleus in the mature cell is commonly pushed to one side while the crystals occupy the center of the cell, which enlarges during the development of the raphides and usually in a longitudinal direction. In some forms cells bearing raphides have been observed which are twenty times longer than wide (*Vanilla planifolia*). Sometimes when these cells occur in series, the cross walls between them may disappear entirely, due to their vigorous growth in length. According to Kohl the crystals remain unchanged in size and number until the cell disintegrates. Sooner or later these cells contain a homogeneous translucent slime. He says, "Dieser Schleim ist es jedenfalls, welche die den Raphiden eigenthümliche Zusammenlagerung veranlasst." Kohl gives a list of plants which contain cells bearing raphides. This list comprises over one hundred species of monocotyledons and thirty-four species of dicotyledons.

Möbius (1908) attributed to mucilage in cells bearing raphides the rôle of protecting the protoplasm from injury by the pointed crystals.

Lloyd (1919), in a paper on mucilage secretion in the cacti, the Malvales and *Astragalus gummifer*, concludes that the slime is in each case a product of the primary cell wall. He considers the relation of slime to growth as very important since the early differentiation of slime cells in the region of the growing point indicates a mechanical function connected with the growth process, the slime cells constituting an imbibition apparatus which forces the membranes to stretch and thus acts as a factor of growth.

Miss Stewart (1919) has also investigated mucilage secretion in certain cacti. She concludes it to be a product of the protoplast since the middle lamella of the wall between the cells which bear mucilage and those which do not is equally distant from the protoplast in both cases, showing that the cell wall has remained unchanged in the slime cell. Her conclusion as to the relationship of mucilage to growth agrees with Lloyd's. In her description of the development of a mucilage cell she shows that the enlargement of the cell in the early stages is accompanied by increased density in the cytoplasm, and that the nucleus becomes larger, so that not only is there an increase in the volume of the cell, but the mass of material other than water is also augmented. As the slime cell becomes mature this dense cytoplasm with the nucleus is crowded to the centre of the cell and appears disorganized or may even disappear.

Czapek (1913 and 1921) recognizes:—

1. The slime which covers the epidermis of seeds, such as in *Linum*, the Lythraceae, and *Plantago*. This slime, he considers, arises from secondary thickening of the cell wall. It may exude from the cell upon the epidermis or into intercellular spaces.

2. The slime which arises from a specialized layer between the cell wall and the cytoplasm.

3. The slime which arises in the protoplast. Cells bearing raphides and the slime cells of various species of orchids belong to this class, which has been called cell content slime or mucilage. Czapek considers the protoplast slime cells in most of the epiphytic orchids as water containers. In the underground tubers of orchids as well as in the slime endosperm of many leguminous plants he looks upon these slime cells as stores of reserve carbohydrates.

The cell membrane slimes, he says, seem never to play the rôle of reserve food material, but to serve as imbibition mechanisms, a protection against excessive transpiration, a means of holding water during the germination of seeds, a mechanism for anchoring seeds to a substratum, a protection of water plants from animal enemies, and as facilitating gliding in growth.

The material chiefly used in the present investigations was buds and flowers of the orchid *Aspasia* sp., but more fragmentary observations were made also upon the orchids *Polystachya minuta*, *Oncidium stipitatum*, and *Orchis spectabilis*. *Aspasia* sp., *Oncidium stipitatum*, and *Polystachya minuta* were grown in the greenhouse of the botany department at Columbia University. *Orchis spectabilis* was collected May 1, 1921, near Tarrytown, New York.

In the study of the mucilage and the raphides paraffin sections of young buds and mature flowers were treated with a variety of staining reagents, mainly the triple stain of safranin, gentian violet, orange G.; the double stains, acid fuchsin and iodine green and safranin and aniline blue, were likewise found useful. Both fresh material and paraffin sections were also stained with ruthenium red, which brought out the middle lamella clearly. Fresh material was stained with corallin soda, methylene blue, and various aniline dyes, but all these observations on fresh material, while they corroborated the conclusions reached with the paraffin sectioned material, were not as satisfactory as the study of the microtome sections. The one determination which it was possible to make with fresh material and not with fixed was the number of crystals in bundles of raphides. When corallin soda is placed upon free hand sections of *Aspasia* sp. the mucilage in the cells containing crystals loosens up, making it possible to count the number of needles in a cell. In a large number counted the crystals varied from thirty to forty, most of the cells having from thirty-two to thirty-five. The variation seemed to be independent of the length of the bundles or the size of the cell in which they are borne, the small bundles having as large a number as the larger ones.

Cells containing mucilage and raphides were found abundantly distributed throughout the floral parts, longitudinally placed with reference to the long axis of the ovary. They were

found fully developed in very young buds, showing that they are associated with actively growing regions. No slime cells in the process of development were found in the mature flowers. The region immediately surrounding the mucilage cells in young buds was characterized by actively dividing cells. All stages in the formation of mucilage were seen. The first indication that a cell will produce mucilage is the enlargement of the nucleus. The cytoplasm in such a cell is denser than in the neighboring cells and there is no large central vacuole. The cell has also enlarged somewhat. The measurements of cells which do not bear mucilage varied from 14 μ to 19 μ in width by 26–22 μ. Those which are enlarged in preparation for producing mucilage are 22–29 μ in length by 22–26 μ in width. The next stage in the development of the mucilage-bearing cell is the appearance in the enlarged cell of a small rather centrally placed vacuole. Before it has enlarged conspicuously a small bundle of raphides is formed in it. The raphides enlarge with the growth of the cell, which now stretches longitudinally. The average dimensions of such cells are 18.5 × 74 μ. The average dimensions of the bundles of crystals in these cells are 14.8 μ in width by 65.5 μ in length. The crystals are apparently suspended in the vacuole by strands of a substance which stains red with the triple stain and which also surrounds the crystal as a thin sheath. This envelope about the bundle in the mature cell is enlarged into a knob-like mass at the end of the bundle, in which highly refractive drops may sometimes be seen. Droplets of the same character were observed occasionally over the entire surface of the bundles of raphides giving the sheath a curdled appearance. The raphides have practically attained their ultimate size before there is any indication of the homogeneous yellow staining mucilage which finally almost fills the mature cell. The mucilage first appears as a thin layer inside the primordial utricle and surrounding the central vacuole. The mature cells have the following dimensions, in microns:

Mature mucilage cells in bud 8 mm. in length		Bundles of raphides in corresponding cells	
Width	Length	Width	Length
37	351	15	74
26	185	16	67
32	93	15	66
37	266	19	63

Mucilage cells in mature flower		Bundles of raphides in corresponding cell	
Width	Length	Width	Length
37	241	19	74
37	259	19	74
26	204	15	74
37	296	15	74

Such a cell contains a large bundle of crystals imbedded in a homogeneous mass of mucilage stained yellow by the orange of the triple stain. Between the mucilage and the cell wall there is a layer of cytoplasm in which the large nucleus with a conspicuous nucleole and chromatin is imbedded. In face view the nucleus is oval in outline and in profile view it is seen to be somewhat flattened against the cell wall. These nuclei appear quite normal. The chromatin takes the blue and the nucleole the red in the triple stain. The appearance of the nucleus in the mucilage cells of *Aspasia* sp. is very different from that described by Miss Stewart, Lloyd and Walliczek for the nucleus in the cactus slime cells. In the mature slime cell of the *Aspasia* it still has the aspect of an actively functioning organ; in the cactus the descriptions show that it is degenerating and lacking the normal differentiation into nucleole, chromatin, nuclear membrane, etc. There was no indication in the mature flower of any change in the character of the secretion in the mucilage cells. No chloroplasts or starch were observed in the slime cells. The only inclusions seen were small oval bodies which stained a bright red like the envelopes and strands of the bundles of raphides. In *Aspasia* sp. raphides and slime were always found associated and neither was found in a mature cell without the other. The crystals dissolved in hydrochloric acid without forming bubbles, showing that they are calcium oxalate. They were not observed in epidermal cells, and there was no evidence of their disappearance in the open flower stage. The sac about the bundle of raphides in no case observed took the same stain as the surrounding mucilage.

ONCIDIUM STIPITATUM

Abundant production of raphides imbedded in mucilage was observed in this species. The red staining sheath about the bundles was not as conspicuous as in the cells of *Aspasia* sp.

I observed no knob-like masses at the ends of the raphide bundles such as were found in *Aspasia* sp. Only buds were observed in this form. Further study is needed to determine the condition of crystals and mucilage in mature flowers.

POLYSTACHYA MINUTA AND ORCHIS SPECTABILIS

I can state that raphides associated with mucilage are found occurring plentifully in both these forms, but I have not as yet studied them cytologically.

The association of raphides with slime in the cell-content slimes has interesting and suggestive implications. Spoehr (1917), in discussing the pentose sugars in plant metabolism, points out that pentoses and hexoses are the most common forms of carbohydrates in plants and that they are transformed with ease and in multifarious ways into other compounds in the presence of organic salts, acids or alkalis. In the cell which produces raphides oxalic acid at least is obviously produced in excess and may be concerned in the transformation of sugar into a polysaccharide mucilage. Mucilages are generally considered to be polysaccharides of sugar, though O'Sullivan contends that mucilages and gums are not polysaccharides but glucoside derivatives of certain organic acids, the acid being different for each species producing mucilage. Hare (1911) claims that, so far as the opuntias which he analyzed are concerned, this view seems correct since the amounts of sugar and ash obtained were not sufficient to account for the total solids, and the residue from hydrolysis contained an undetermined organic acid. In this connection it is interesting to note that Bourquelot and Bridel (1920) discovered a new glucoside in *Orchis*, loroglossine, and that in eighteen species of native orchids which they studied glucosides were found abundantly. It is to be remembered, however, that the formation of a mucilage cell is a very complex process. It begins with the hypertrophy of nucleus and cytoplasm. The raphides appear before the mucilage does. Mucilage formation seems to follow the appearance of the raphides in the central vacuole. While the mucilage may be formed at the expense of the cytoplasm my preparations show most clearly that it is a secretion process and not one of mere degeneration. Whether slimes are polysaccharides or glucosides the evidence in the floral organs of *Aspasia* sp. is

that the region of the raphides is a formative one since the envelope of the needles stains differently from the mucilage about it, and that drops of still different character are sometimes seen in the mass of material at the ends of the bundles as well as along their surfaces. The size of the crystals changes less during the life of the slime cell than the amount of mucilage does in the same period as a reference to the measurements of raphides and mucilage cells show. The normal appearance of the nucleus also indicates a living and active condition in the slime cell up to its mature condition. If the formation of mucilage in these slime cells is a continuous process during the life of the plant organ in which the cell occurs, the manner of secretion may be compared to that in the gland cells of animals which secrete continuously or periodically.

MacDougal (1920) claims that the measurements of variations in length and thickness of the succulent leaves of *Mesembryanthemum Phaseolus* and *Opuntia* yield ample evidence that the fluctuations in their growth show a direct relation to the hydration capacity of the growing cell masses, and that the high hydration capacity of *Opuntia* is due to the mucilage which it contains. The source of energy in hydration he attributes to the unsatisfied attraction of molecules or particles or ions bearing electrical charges. Polysaccharides, he says, appear to determine the water relations of living matter. He further says, "Growth consists in increases in volume of masses of living matter, usually but not invariably accompanied by accretions of material other than water to the colloids of the protoplasm." In the early stages of mucilage formation in the cells of *Aspasia* sp., just as Miss Stewart has shown for the cacti, there is obviously an accretion of material other than water as the increased size of the cell completely filled with dense cytoplasm proves. The transformation of this cytoplasm into slime may be a process of hydration and involves the imbibition of water from adjacent cells. If the process is simply one of imbibition of water it might better be regarded here as a degenerative rather than a growth process. As noted, however, my preparations show that the nucleus maintains its organization intact to the end. There is also a well-developed cytoplasmic primordial utricle in the mature slime cell, so that in my opinion we have here the case of a true secreting cell in which

the material secreted is deposited in a central vacuole rather than being poured out into ducts as in the secreting glands of animals or being deposited between the plasma membrane and cell wall as is the cacti. During the later development of the slime cell, the assimilation of material other than water may be also going on if material (starch or sugars) from the adjoining cells is being made into mucilage.

The formation of raphides may be primarily dependent upon the supply of calcium in the soil (Kohl) and upon the supply of nitrates in the soil (Czapek). Oxalic acid may be formed in vitro by the oxidation of many carbon compounds with nitric acid. Czapek points out a connection between nitrates and oxalic acid in plants, saying that in certain forms it has been demonstrated that oxalic acid is produced abundantly when nitrates are given in excess, but that when nitrates are withheld, otherwise flourishing plants contain at most only slight quantities of oxalic acid.

As to the function of raphides, various views are held. Stahl believes them to be a protective device to prevent plants being eaten by animals, but subsequent studies by Leuvin (1901) have proved this theory unfounded. Groom (1896) suggests that the precipitation of calcium oxalate neutralizes the poisonous effect which potassium oxalate has upon plants. Czapek considers that in some cases at least raphides serve as reserve food stuff. In support of this view he cites Sorauer's report that these crystals disappear in the living cells of *Orchis* tubers, as well as DeVries's observation on ripening potato tubers and his own observation of the same phenomenon in *Begonia* cuttings.

The classification of plant slimes rests so far upon superficial appearance rather than upon inherent characters. This kind of grouping is probably responsible for the confusion in the literature dealing with them. Yet since the time of Frank (1867) three types have been clearly recognized. Tschirch (1889) substitutes "Schleime-epidermis" for Frank's intercellular class; Walliczek (1893) accepts this classification, finding great difficulty, however, in being definite about any slimes which have certainly been proved to belong to the cell content slime, including in this class only that which occurs in *Symphytum* and *Orchis* tubers; Kraemer (1908) recognizes cell content mucilage arising as a product of the protoplasm, and cell membrane mucilage derived from cell walls.

Plant parts with slimes belonging to the first class are apparently tubers of *Orchis* sp., rhizomes of *Agropyron repens*, bulbs of *Urginea maritima*, bulbs of *Allium* sp., stem and leaf elements of flowers (excepting stamens) of *Viola tricolor*, *Hagenia abyssinica*, *Musa paradisiaca*, and succulent plants such as the aloe.

Cell membrane mucilage Kraemer describes as either a degeneration of the cell wall or a secondary thickening, as an addition to the cell wall or some metamorphosis of it. Plant parts with slimes of this class are roots of *Althea officinalis* bark of cinnamon, bark of *Rhamnus Frangula*, rind of root of *Sassafras officinale*, inner bark of *Alnus Frangula*, pith and medullary ray cells of *Astragalus gummifer*, parenchyma cells of wood and bark of cherry and *Acacia senegal*, glandular hairs, leaf and calyx of *Viola tricolor* and leaves of *Coffea arabica*.

Czapek's classification of plant slimes as given above is probably the most complete and clearly formulated at the present time. Lloyd and Miss Stewart report raphides as occurring in certain species of cacti which by Czapek are classed as having cell membrane slimes. Whether or not cells bearing raphides sometimes contain mucilage derived from the cell wall is a matter that needs further study.

CONCLUSIONS

It is clear from my studies that, as Kohl also showed for certain orchids, in the floral organs of *Aspasia* sp. and *Oncidium stipitatum* the mucilage must originate in the protoplast, since the cytoplasm and the nucleus lie between it and the cell wall. In these forms mucilage cells were found in the young actively growing regions. This mucilage can hardly have the functions ascribed to that found in orchid pseudo-bulbs. In all forms investigated mucilage and raphides were found associated and neither was seen without the other.

The appearance of the nucleus and cytoplasm in the slime cell indicates that it is in a living and active condition. This is in sharp contrast to the description which has been given by Miss Stewart and others of the appearance of the nucleus and cytoplasm in the *Cactus* slime cells where the nucleus and cytoplasm are in a disorganized state.

In concluding I wish to express my gratitude to Dr. R. A. Harper, by whom these investigations were directed, for his assistance and illuminating suggestions.

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Explanation of plate 1

The figures were drawn with the aid of a camera lucida. With the exception of FIG. 4 all were drawn from paraffin sections of a young bud of *Aspasia* sp., which was fixed in Flemming s medium solution and stained with Flemming s triple stain. FIG. 4 was drawn from a free-hand section of fresh material stained with ruthenium red. Magnification of all except FIG. 4, × 1280.

FIG. 1. Hypertrophied cell with dense cytoplasm in which there is a suggestion of a vacuole. This cell, which will produce crystals and mucilage, is surrounded by smaller vegetative cells. The nuclei of two such cells are shown.

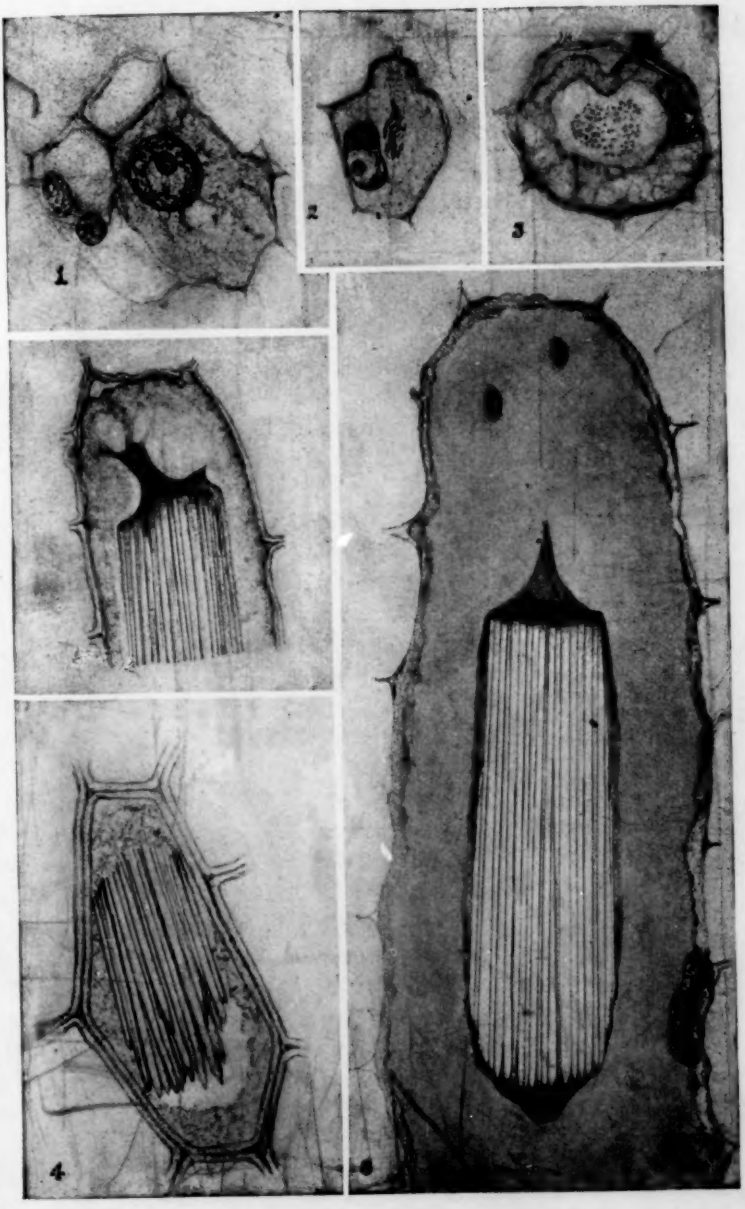
FIG. 2. Cell with enlarged crystals in a vacuole.

FIG. 3. Cross section of young mucilage cell showing nucleus with bundle of crystals in the center.

FIG. 4. Cell from a free-hand section of a mature flower stained with ruthenium red. The crystals are probably displaced by cutting. The middle lamella and thickness of the cell wall are clearly brought out with the ruthenium red. The cytoplasm does not yet show the homogeneous appearance of mucilage.

FIG. 5. Portion of a cell showing the sheath-like envelope around the bundle of crystals and its connection with primordial utricle of the cell.

FIG. 6. Portion of a mature mucilage cell showing a thin layer of cytoplasm between the mucilage and cell wall. In it an elongated deeply staining nucleus with nucleole is imbedded. The mucilage is stained a pale yellow the sheath around the crystals a bright red.



SMITH: HISTOLOGY OF ORCHIDS

Apogamy in Phegopteris polypodioides*

ELIZABETH DOROTHY WUIST BROWN

(WITH TWENTY TEXT FIGURES)

INTRODUCTION

The wide-spread occurrence of apogamy in various genera of ferns has led to a great deal of investigation of the subject. In most of this study, however, greater emphasis has been laid upon the morphological and cytological than upon the physiological phase.

Leitgeb ('85), who was the first to study apogamy from this latter point of view, carried out a series of experiments to determine the light reactions of apogamous fern prothallia. Among the things he discovered was the fact that when prothallia of *Aspidium falcatum* bearing very young sporophytes were illuminated from the ventral side, the sporophytes were suppressed, new ones being formed on the dorsal side. In rare cases both dorsal and ventral sporophytes would survive and then they seemingly would give rise to a single sporophyte, with its various parts on both sides of the prothallium. Leitgeb considers the alterations of the light relations, during the growth of the prothallia, to be the probable cause of some of the modifications in the apogamous sporophytes described by DeBary ('78).

Bower ('88), although he did not make a physiological study of apogamy, calls attention to the importance of the environmental conditions in the life history of a fern. He cites the fact that the Hymenophyllaceae are exceedingly susceptible to changes of moisture in the air, and concludes that such changes react upon their mode of growth.

Lang ('98) found, in the case of nine different ferns, that by exposing the prothallia to direct sunlight and watering them from below, a condition favorable for vegetative growth but preventing fertilization, sporophytes were produced, although some of them were aborted.

Nathansohn ('00), experimenting with *Marsilia Drummondii*, concluded that exposure to higher temperature for a limited

* Contribution from the Osborn Botanical Laboratory.

time stimulated the development of apogamous embryos in this species.

Woronin ('07) believes dryness to have been the cause of apogamy in the cultures of *Pellaea* and *Notholaena* with which she worked. By growing the prothallia of *Pellaea flavens* in poor light or on poor soil she was able to secure modifications in apogamous outgrowths, which showed transitions between gametophytes and sporophytes as varied as those described by Lang.

Yamanouchi ('08), in his study of *Nephrodium molle*, found that when conditions for fertilization were supplied this species reproduced normally, but that if the cultures were placed in strong light and watered from below fertilization was prevented and apogamous outgrowths were formed instead.

Outgrowths of an apogamous nature were described by Miss Pace ('10) as occurring on some unidentified prothallia which she kept well watered in bright light.

Heilbronn ('10), finding that dryness was not the cause of apogamy in the forms he studied, suggested that summer rather than winter cultures were more likely to become apogamous. But his investigations with different qualities and intensities of light, in moist cultures and at a high temperature, did not verify these conclusions.

Schlumberger ('11) found that by decreasing the moisture for old prothallia of *Woodsia ilvensis*, whose vitality had become lowered by the growth of algae and fungi in the cultures, the production of apogamous outgrowths was induced. He believes the observed enlargement of the apices of these apogamous outgrowths to be analogous to that described for *Anogramma chaerophylla* by Goebel ('97), who considered their development to be an adjustment on the part of the plant to the unfavorable environmental conditions caused by dryness.

Allen ('11) found apogamous sporophytes occurring on prothallia of *Aspidium falcatum* which had been grown in pots of red clay surrounded by sphagnum or moist sand, and kept either in a Wardian case or under bell jars for five, six, and in one case eleven months. These prothallia were not watered from above, the water in the sphagnum or sand keeping the clay uniformly moist.

Nagai ('14), describes cases of apogamy on prothallia of *Asplenium Nidus* grown on agar-agar and on filter paper saturated with nutrient solutions. These cultures were kept somewhat dry, in bright light, and at room temperature. The occurrence of apogamous sporophytes is also described on prothallia which, after growing on nitrogen- and phosphorus-free nutrient solution, had been transferred to sand saturated with nitrogen-free nutrient solution and left in bright light and at higher temperature. He does not attribute the development of these apogamous outgrowths to dryness but to unfavorable or unknown internal physiological conditions.

Stokey ('18) reports a case of apogamy in the genus *Dicksonia* and a few cases in the genus *Cyathea*. These occurred in cultures which had been exposed to rather intense light and grown on a medium of moist peat. While she does not consider dryness to be the determining factor, and while she does not state definitely that the intense light was the stimulus, she is of the opinion that the determining factor in one case of apogamy is not necessarily the determining one in another.

Steil ('18) found apogamy occurring in the genera *Pellaea*, *Pteris*, and *Aspidium*, in cultures on nutrient solution, sphagnum, nutrient agar, peat, clay, and loam, which were kept under bell jars in a Wardian case in the greenhouse. He does not consider the cultural conditions as the factor which induces apogamy in any of these cases.

MATERIAL

While collecting fern spores in and about Ithaca, New York, during the summer of 1915, my attention was called to a sporophyte of *Phegopteris polypodioides* Fée growing on a lawn in the city. It had been transplanted from its native habitat and did not appear normal or healthy, owing, doubtless, to the unfavorable conditions under which it was growing. As there was only one fertile frond, and this a small one, few spores were obtained. Cultures were made from these spores in the early fall upon Prantl's and Knop's full nutrient solutions and on certain modifications of these solutions. After the spores were sown the cultures were placed before an east window where conditions of light and temperature were approximately uniform for all. Once each week the prothallia were transferred to fresh

nutrient solutions. About six months later, cases of apogamy were observed in cultures on Prantl's solution from which the NH_4NO_3 had been omitted. In view of the small number of such cases, however, it was thought best to repeat the experiments, and also to make cultures from spores of the same species whose sporophytes had grown under normal environmental conditions. In this way it was hoped that it might be possible, by a comparison of the results obtained, to determine whether apogamy was characteristic of this species, and, if so, under what environmental conditions this condition was induced.

For this purpose, during the following summer (1916), fresh spores were obtained from the same plant at Ithaca and also from wild plants at Brooklin, Maine (the latter through the courtesy of Dr. A. H. Graves). Cultures of these were started early in October on Prantl's and Knop's full nutrient solutions; on modifications of Prantl's solution from which NH_4NO_3, K_2SO_4, NaCl, $CaSO_4$, $MgSO_4$, Na_2PO_4, and both NaCl and Na_3PO_4, respectively, were omitted; and on Knop's solution minus the $Ca(NO_3)_2$. In preparing the cultures, about 25 cc. of the nutrient medium was poured into a small glass dish, a drop of a 1 per cent solution of ferric chloride added, and the spores sown upon the surface of the solution. The dishes were covered with loose-fitting glass tops. Two series of cultures were prepared from each of the two lots of spores, one of which was placed in the greenhouse in bright light, the other in the laboratory before an east window. The germinating prothallia, instead of being transferred at intervals to fresh solutions (as had been done the preceding year) were allowed to remain upon the original solution on which the spores were sown, and the increasingly unfavorable conditions of environment which thus resulted were further enhanced by a luxuriant growth of algae which developed in all the dishes.

DEVELOPMENT OF THE PROTHALLIA

Practically no difference was noted in the germination of the spores or in the early development of the prothallia from the two sources. Germination began in about one week after the spores were sown. The early growth and development of the prothallia was rapid in all the cultures, but later it varied according to the particular solution upon which they were growing.

In the case of the cultures which were kept in the greenhouse, the majority of the prothallia growing on the modified Prantl's and Knop's solutions did not develop beyond a filamentous stage and lived only from five to six weeks. This behavior was attributed to temperature rather than light: the temperature in the greenhouse being very high during the greater part of the day, the culture media became overheated, with the result that the prothallia, lacking in vigor on account of an insufficient supply of some essential element in the nutrient solution, were unable to withstand the unfavorable conditions of temperature. A few prothallia in the greenhouse cultures on Prantl's and Knop's unmodified solutions survived, however, and developed into normal heart-shaped thalli.

The length attained by the prothallium during its filamentous stage varied greatly, but even in cultures on the full nutrient solutions it was not uncommon to find prothallia with filaments of seven and eight cells in length. These usually occurred in crowded regions of the cultures. In the cultures on the modified solutions the length of the filaments was even greater, some having as many as twelve to fifteen cells. The length of the cells also varied, some being long and others short, but with the long cells predominating. It is customary for the length of the filament of the prothallia of any species of ferns to vary under unfavorable environmental conditions, but the range of variability in length seems fixed for each species. In this respect *Phegopteris polypodioides* showed the greatest range of variability of any prothallia of the Polypodiaceae that have come under the author's observation.

Branching was exceedingly varied and occurred frequently in the cultures on the modified solutions, while on the unmodified solutions it was not uncommon. Many times the first cell of the filament, instead of dividing transversely, divided lengthwise, giving rise to two distinct filaments, which later broadened into prothallia. Sometimes other cells of the filaments divided, giving rise to branches which in turn broadened into prothallia. In other cases a filament of three cells was first formed, and then the first and second cells of the filament divided lengthwise, giving rise to side branches. These side branches continued their growth as filaments for a time, and then branched dichotomously. In still other cases the end cell of a filament of four

cells elongated transversely instead of longitudinally and divided crosswise, giving rise to two distinct branches which in turn branched. Some of these branches, after broadening into filaments of two cells in width, reverted to a one-cell stage. Again a short filament was formed, which broadened out, and then, from this broadened region side branches were formed; the cells of the apical margin of the broadened portion also gave rise to branches which in turn formed other branches. Some of these branches, after forming either a long filament or a short one of only three cells, broadened into a prothallium bearing antheridia, after which it reverted to a filamentous condition. This capacity of the prothallia to branch extensively seems to be of advantage to the plant in enabling it to meet unfavorable environmental conditions, by increasing the number of prothallia, thus giving rise to an extended area of rhizoids, as well as insuring the formation of a larger number of sporophytes, either normally or apogamously. Atkinson designates the branched prothallia of *Adiantum cuneatum* described by him as "starved prothallia," and the author ('16) has shown that branching in various prothallia of the Polypodiaceae is intimately associated with conditions of nutrition, poor nutritive conditions accelerating the stimulus for branching and good nutritive conditions weakening it. Another interesting feature in connection with the development of the young prothallia in the modified solutions was the frequency with which they met the unfavorable conditions for nourishment by reversion to a filamentous condition. Prothallia several cells in width and bearing antheridia would revert to a filamentous condition; then, after forming a filament three to eleven cells in length, they would broaden again to form a prothallium which in turn bore antheridia. Goebel considers a reversion to a juvenile form to be the result of unfavorable conditions, which in this case was doubtless an insufficient food supply.

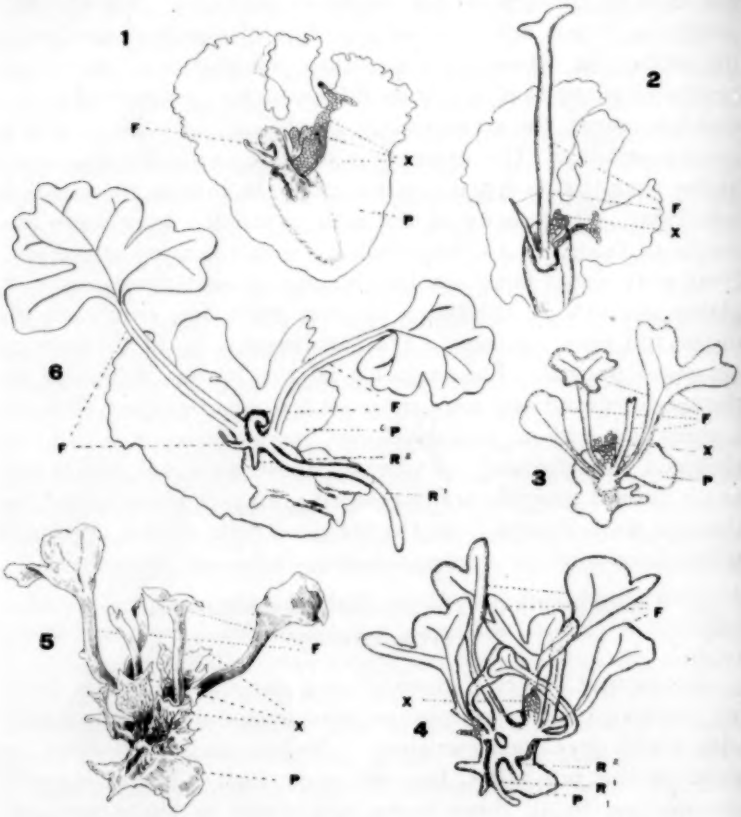
In the cultures which were kept in the laboratory, sexual organs, both male and female, developed on the prothallia in all the solutions, both modified and unmodified. They also developed on the few prothalia which survived on the unmodified solutions in the greenhouse cultures. Antheridia appeared in four to six weeks after the spores were sown. Both monoecious and dioecious prothallia occurred in the laboratory cultures on

the unmodified Prantl's and Knop's solutions, while only dioecious prothallia were observed in the greenhouse cultures on the same solutions. In the younger cultures, those not more than six or eight weeks old, the majority of the prothallia were dioecious, the percentage of monoecious individuals being very low even in cultures on the modified solutions. Among older prothallia it was not infrequent to find monoecious specimens, the antheridia developing on or near the margin of the larger heart-shaped prothallia. Antheridia were never observed on the cushion, among the archegonia, as is the case in typical monoecious prothallia. The percentage of male prothallia was much higher than that of female, as is usually the case on the modified solutions. While many of the male prothallia were mere filaments of from one to three cells in width bearing antheridia, there were also a large number of small irregularly-shaped cell-plates one cell in thickness, bearing antheridia over both the upper and lower surfaces. The antherozoids in all the cultures appeared normal. The majority of the larger prothallia on the modifiedsolutions were more or less heart-shaped, without a sinus but with a well-developed meristem upon which archegonia were formed. Evidently these were not functional, as no normal sporophytes developed. In rare cases a few antheridia were formed from the marginal cells of the prothallia which developed the apogamous outgrowths and sporophytes.

DESCRIPTION OF THF APOGAMOUS OUTGROWTHS AND SPOROPHYTES

In the first observed cases of apogamy the prothallia bearing the apogamous sporophytes were irregularly heart-shaped, with a well-developed meristem. Archegonia were formed on some of the prothallia, but not antheridia. The apogamous sporophytes, in all these cases, originated as slight swellings of the archegonial cushion, either on the dorsal or ventral side, at some point near the notch or at the center of the cushion. These swellings gradually increased in size until dome-shaped cellular masses were formed, from which the parts of the apogamous sporophytes appeared in the following order: leaf or leaves, root, and stem. No foot was formed. In some cases proliferations, either filamentous or slightly expanded at the apices, developed from the cellular mass. Also, multicellular

hairs or outgrowths frequently formed at the base of the first leaf or leaves of the young sporophytes. FIGS. 1–4 show the development of one of these apogamous sporophytes. In this case the prothallium was lobed and the apogamous sporophyte developed at the center of the cushion as a cellular mass (FIG. 1).



FIGS. 1–6

From this cellular mass, seven normal leaves were developed before a root was formed. Soon after the first root formed, another began to develop (FIG. 4). Meanwhile the old prothallium became greatly reduced in size. The subsequent growth of the apogamous sporophyte was normal and rapid. FIGS. 5 and 6 represent other examples of apogamous sporophytes.

In the experiments of the second year apogamous outgrowths were first observed in the laboratory cultures on Knop's full solution about four to six months after sowing. Subsequently they developed in essentially all the cultures. These outgrowths were very diversified in form, and while some originated as cellular masses, at various places on the archegonial cushion, the majority developed as outgrowths of the prothallia in the region where the sinus usually occurs. It was only in rare cases that sexual organs, either antheridia or archegonia, formed on the prothallia bearing apogamous outgrowths.

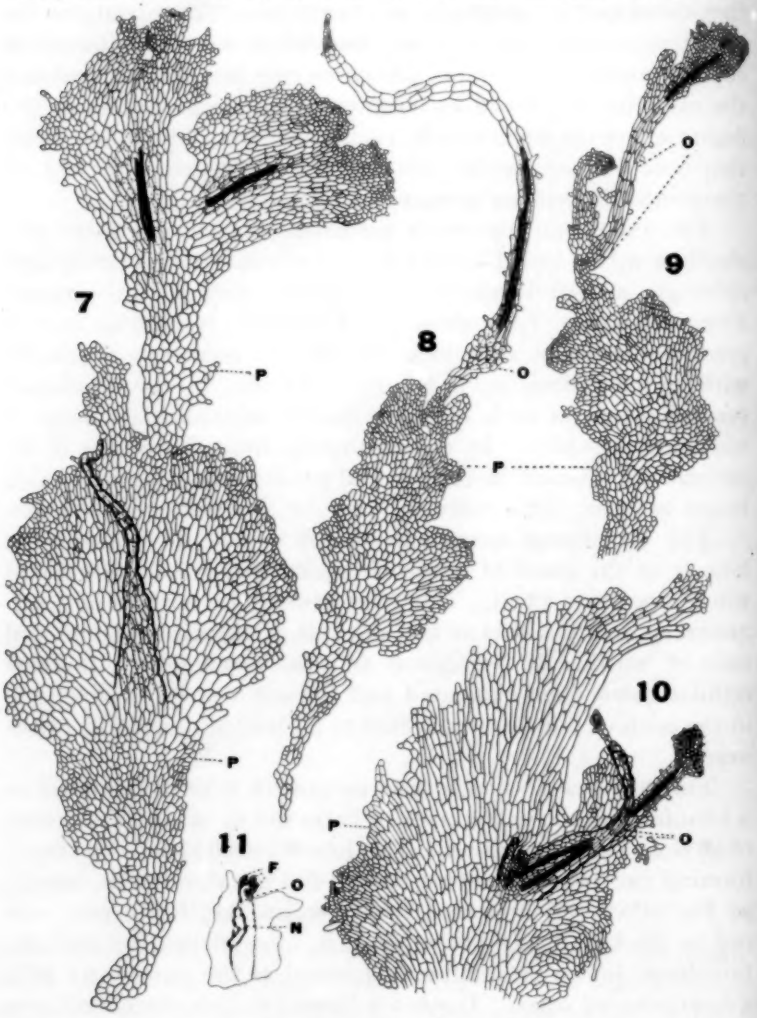
FIG. 7 shows an apparently normal and slightly elongated prothallium with a broad lobed apex. No sexual organs developed, although a well-developed archegonial cushion was present. From the region of the sinus a lobe formed. Narrow at first, it gradually widened and then branched to form two prothallia with broad apices, each having a sinus. In the thickened central region of each of these branch-prothallia a cluster of tracheids appeared. In the meantime, from the center of the archegonial cushion of the original prothallium a cellular mass began to form. This continued to grow as a thick conical mass.

The apogamous outgrowth shown in FIG. 8 formed as a lobe from the sinus of a very irregular, elongated prothallium whose apex was lobed. This lobe, which later became an apogamous sporophyte, was at first one cell in thickness and several cells in width. It broadened and thickened into a bulbous cellular mass, then elongated and formed a series of tracheids in the center. Finally it reverted to a filament one cell in thickness.

FIG. 9 shows an apogamous outgrowth which originated as a lobe from the irregular apex, a little to one side of the center of an elongated prothallium. This lobe broadened and thickened, forming two branches. One branch did not develop as rapidly as the other and appeared more thallus-like, being only one cell in thickness. The other branch, after elongating slightly, broadened into a prothallium thickened at the center and with a heart-shaped apex. Tracheids formed in this thickened area and a small branch developed at one side of the prothallium near the apex.

The apogamous sporophyte shown in FIG. 10 developed first as a cellular mass on the meristem near the sinus of a very

irregular-shaped old prothallium whose basal portion had died. The apex of this prothallium was strongly indented, the sinus being situated slightly to one side of the middle. From one



FIGS. 7–11

side of the prothallium a very much branched proliferation developed, while from the cellular mass outgrowths resembling somewhat the normal leaves of young sporophytes were formed.

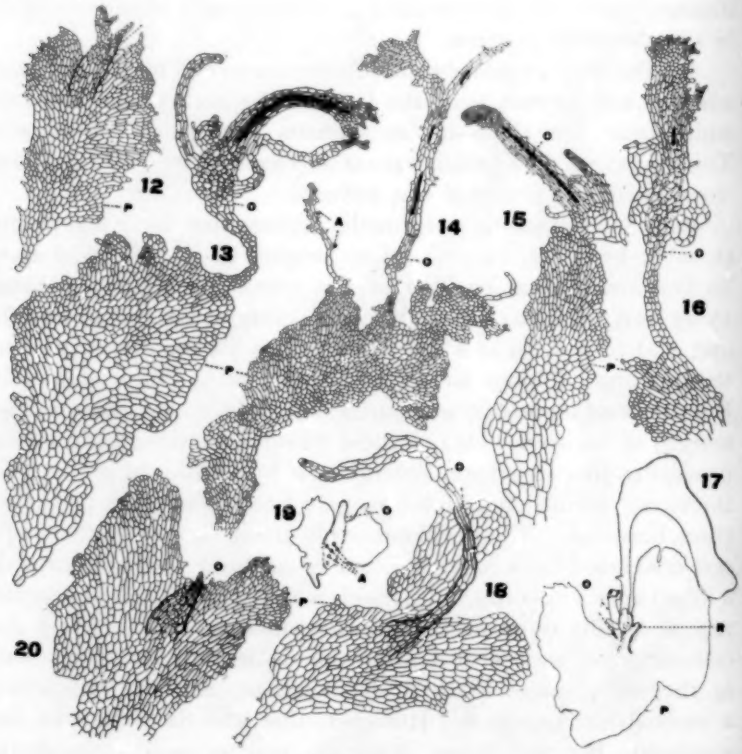
The first outgrowth, after forming an elongated flat structure several cells in thickness and width, broadened into a prothallium with a slight sinus. Tracheids formed in the thickened region at the center. The second outgrowth continued its development as an elongated, thick, club-shaped structure bearing tracheids near the base. The third outgrowth at a very early stage formed a slightly elongated prothallus-like structure, distinctly notched and bearing a series of very short tracheids in the elongated portion.

On the very irregular prothallium shown in FIG. 11 a normal embryo was formed near the base of the archegonial cushion, while near the sinus an apogamous sporophyte developed. This appeared as a cellular mass surrounded by proliferations, from which the first leaf was formed.

Of the apogamous outgrowths represented by FIGS 12–20, those of FIGS. 12, 16–18, and 20 originated as cellular masses on the archegonial cushion of the prothallia; those of FIGS. 13–15 originated as lobes from the margins of the prothallia and that of FIG. 19 as a lobe in the sinus. The cells in most of these marginal lobes were large. The prothallium shown in FIG. 13 was somewhat elongated and bore many lobes on the margin of its apex. One of these lobes, after elongating into a prothallus-like structure, several cells in width and one cell in thickness, formed a cellular mass. From this were given off three branches. The development of the apogamous outgrowth was continued by a reversion to a broad thick prothallium with a lobed apex. A series of tracheids were formed in the thickened region of this outgrowth. All the branches given off by the cellular mass were curled after the manner of a normal leaf, in the early stages of their development, and one resembled a normal leaf in shape. However, this was the extent of the similarity between these branches and normal sporophytic leaves. The branches were only one cell in thickness and no tracheids were present.

The apogamous outgrowth shown by FIG. 14 occurred as a lobe on the margin of a very irregular and distinctly notched prothallium, in the region of the sinus. From only a few cells in width the apogamous outgrowth developed into an elongated prothallus-like structure, thickened in the center and branched at its apex. One of these branches was narrow and several

cells in thickness, while the other was wider, only one cell in thickness, and with a broad notched apex. Series of short tracheids were formed in both the thickened region of the elongated portion of the sporophyte and on its branch. Another outgrowth, prothallus-like in form, developed from the margin of one wing of the prothallium and bore on its margin an antheridium.



FIGS. 12–20

FIG. 15 shows an apogamous outgrowth which developed by the narrowing and lengthening of the apex of a prothallium one cell in thickness. It soon branched, one branch being very irregular in form and only one cell in thickness. while the other was elongated and several cells in thickness in the central region where it bore a group of long tracheids. A small side branch was given off from the apogamous outgrowth.

The prothallium, upon which the apogamous outgrowth formed as a lobe in the sinus, was irregularly heart-shaped and bore archegonia on a well-developed meristem (FIG. 19).

With the exception on the one shown in FIG. 16, all the prothallia upon which apogamous outgrowths originated as cellular masses on the archegonial cushion were distinctly notched, and the apogamous outgrowths first appeared as conical cellular masses, the apices of some being more pointed than others. However, the outgrowth shown in FIG. 18 varied somewhat in its development. Beginning as a cellular mass, it formed an elongated, slightly flattened and thickened prothallus-like structure, which in turn reverted to a filamentous condition.

The apogamous sporophyte shown by FIG. 17 began its development as a cellular mass near the sinus on the archegonial cushion of an irregularly shaped prothallium. From this mass there developed first two structures intermediate between leaves and prothallia and then a root. The first of these intermediate structures resembled a very much elongated prothallium one cell in thickness with an expanded and irregularly lobed apex. The second was curled at first in the same way as a normal leaf but resembled the first in being an elongated prothallus like structure one cell in thickness. The root appeared normal.

DISCUSSION

The factors which are considered as the possible controlling or influencing ones in apogamy, as advanced by the previously mentioned workers, are the following: (1) insufficient water for fertilization, (2) weak light, (3) bright light, (4) high temperature, (5) poor soil. In the opinion of five of the writers cited, lack of sufficient water to permit fertilization to take place is regarded as the controlling factor in the particular ferns with which they worked. In the case of *Phegopteris polypodioides*, as well as in the other cases of apogamy previously described by the author ('19, '20), this factor can be entirely eliminated, since the prothallia were grown upon a liquid medium.

Also the factor of light, either bright or weak, can not be considered as the most important one in these cases of apogamy for the following reasons. (1) All cultures were kept

under light conditions which not only proved sufficient for the production of normal sporophytes but which failed to retard their development in those cultures of the full solutions which were renewed frequently. (2) In cases where apogamous prothallia from a nutrient solution with one of the essential elements omitted were transferred to a fresh full nutrient solution, thereby permitting the vitality of the prothallia to be renewed, no more apogamous outgrowths or sporophytes were formed, although the cultures were kept under the same light and temperature conditions. In some cases normal sporophytes developed. The formation of these normal sporophytes ceased as soon as the new solution was exhausted and the vitality of the prothallia thereby lowered. (3) Some of the prothallia which had developed upon a full nutrient solution, when removed to a solution from which some essential element was omitted, produced apogamous outgrowths or sporophytes as soon as their vitality was reduced. However, relatively few were formed under these conditions because the prothallia of *Phegopteris polypodioides*, when grown from the spores upon a full nutrient solution which afforded the necessary elements for growth and development, were unable to adjust themselves readily to the physiological action of an incomplete solution. The vitality of the prothallia seemed to be lowered so quickly that it was impossible for them to make an attempt to overcome the unfavorable condition for reproduction by producing apogamous outgrowths and sporophytes. The prothallia of various species of ferns seem to differ in this respect, some being more sensitive, while others are more tolerant. (4) Apogamous prothallia occurred frequently in uncrowded regions of the cultures where light conditions were very good, while on the other hand in the cultures of the full solutions normal sporophytes developed in the most crowded regions where the light condition was the poorest.

The factor of temperature can not be considered as the controlling factor in apogamy in *Phegopteris polypodioides*. The prothallia in all cultures, both those which produced normal sporophytes when the food supply was sufficient and those which produced apogamous ones when the food supply was insufficient, were kept under the same temperature conditions.

Poor soil as a factor in causing apogamy would be operative either through the absence of the elements necessary for development or the presence of those elements in such a form as not to be available for the use of the prothallia. In either case it would be a lack of sufficient nourishment which would be the stimulus to apogamy. The results secured on poor soil would compare with those obtained in *Phegopteris polypodioides* where the apogamous outgrowths and sporophytes were due to insufficient nourishment. The proof for this is the fact that no cases of apogamy were observed in cultures of the full nutrient solution when it was renewed frequently; or, in other words, when a sufficient food supply was available. Also, apogamous outgrowths and sporophytes ceased to develop, and in some cases normal sporophytes were formed, when the nutrient solutions were renewed in the cultures, although other factors remained the same. Still further evidence is the fact that frequently the apogamous outgrowths showed a reversion from a more or less complex structure, several cells in thickness, bearing tracheids to a simple prothallus-like body only one cell in thickness and branched, indicating a still greater lowering of the vitality, which was doubtless due to an insufficient food supply.

Prantl's ('81) work on the nutrition of ferns, Klebs's ('93) valuable studies on the physiology of reproduction, and the work of others have demonstrated that an intimate connection exists between nutrition and growth, and between growth and reproduction. Since both growth and reproduction are dependent upon nutrition, it would seem as if nutrition was the most important if not the controlling factor in causing apogamy. Farmer and Digby ('07), Winkler ('08), Allen ('11), and others are of the opinion that the morphological characters of the gametophyte and sporophyte are not determined by the chromosome numbers as such. It would seem as if the morphological features were determined to a large extent by physiological characteristics, and that the difference between the gametophytic and sporophytic tissue was not a marked one physiologically. Apogamy seems to be due in all cases to a lowering of the vitality of the prothallia to such an extent that normal sporophytes can not be formed. This may be brought about by one or more factors working separately or together. Therefore, apogamy may be

regarded, as Bower ('88) has considered it, as a simplification of the life cycle of the fern, or, in other words, as a response to the changed environmental conditions for which a modified life cycle is an advantage to the plant. Doubtless the prothallia of all species of ferns possess this latent quality by virtue of which they can respond to changed environmental conditions by a reversion to this simplified life cycle, which was probably the more primitive.

For this and other reasons the value of the physiological study of the gametophytes of ferns can hardly be overestimated from the standpoint of determining the cause or causes of apogamy and as shedding light upon the physiological problems connected with the interpretation of sexual phenomena and the expression of the individuality of plants in their relation to their environment. The latter point should be emphasized especially, for it is not of so much importance that we determine the exact factor of the environment, which works separately or together with other factors in causing apogamy, as that stress be laid on the individual physiological characteristics of the gametophyte and sporophyte which cause them to respond to the stimulus of the particular situation in the way best adapted to meet their requirements. On account of these individual physiological characterisctics of the gametophyte the same factor or group of factors need not be the cause of apogamy in all species of ferns.

The fact that apogamy occurred frequently in *Phegopteris polypodioides* under cultural conditions unfavorable for nourishment would seem to indicate that apogamy is not a rare occurrence in this species and that it is easily induced.

SUMMARY

1. The filamentous stage of the prothallia of *Phegopteris polypodioides*, grown upon unmodified and modified Prantl's and Knop's solutions, showed a great range of variability in length, the greatest length occurring in the modified solutions.

2. Branching of the prothallia and reversion to a filamentous condition occurred frequently under unfavorable cultural conditions.

3. Sexual organs, both male and female, developed on the prothallia in cultures of the unmodified solutions which were

kept in the laboratory. The percentage of male prothallia was much higher in cultures on the modified solutions, while on the unmodified solutions female prothallia predominated.

4. Both monecious and dioecious prothallia occurred in all the cultures, but the percentage of monoecious prothallia was low, even in young cultures on the modified solutions.

5. Apogamous sporophytes were observed in cultures on Prantl's solution with NH_4NO_3 omitted.

6. Apogamous outgrowths and structures intermediate between mere outgrowths and apogamous sporophytes were observed in cultures on the Knop's full nutrient solution.

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Studies of West Indian plants---XI

NATHANIEL LORD BRITTON

64. UNDESCRIBED SPECIES FROM CUBA

Juniperus saxicola Britton & Wilson, sp. nov.

A densely branched small tree, 3–8 m. high. Leaves all subulate-acicular, subimbricate, somewhat spreading, 4–7 mm. long, about 1 mm. broad at the base, lustrous; fruit blue, broadly ellipsoid or subglobose, 5 mm. long, 3–4 mm. in diameter.

On rocks, crest of Sierra Maestra, Oriente (*Léon 10798*, type); also collected on Farallones de Regino, Estribo Turquino (*Léon 11024*).

Myrica cacuminis Britton & Wilson, sp. nov.

A shrub, 3–4 m. high, much branched, the slender twigs densely pilose. Leaves elliptic to suborbicular, 7–18 mm. long, short-petioled, sharply few-toothed or entire, coriaceous, pinnately few-veined, pubescent on both sides, the apex rounded, the base rounded or obtuse; flowers and fruit not seen.

Pico Turquino, Oriente (*Léon 10973*, type; *Bucher 19*).

Pilea ovalifolia Britton & Wilson, sp. nov.

Stems creeping, rather stout, rooting at the nodes. Leaves chartaceous, elliptic, obtuse or rounded at the apex, rather coarsely crenate, pinnately 3-nerved, glabrous, those of each pair often unequal in size; larger leaves up to 5.5 cm. long, 3.4 cm. wide, with petioles 1.5–3 cm. long; smaller leaves 2.5–4 cm. long, 1.5–2.6 cm. wide, the petioles 1–2 cm. long; upper leaf-surface densely covered with minute linear raphides, the lower surface papillose; pistillate inflorescence longer than the leaves, peduncled, its branches spreading; achenes ovate, about 0.9 mm. long.

Sierra Maestra, Oriente (*Léon 10767*).

Pilea membranacea Britton & Wilson, sp. nov.

Stem slender, puberulent. Leaves membranous, lanceolate to ovate, acuminate, coarsely toothed, 3-nerved, glabrous, those of each pair unequal in size; larger leaves up to 5 cm. long, 1.8 cm. wide, with slender petioles 0.7–1 cm. long; smaller leaves 1–2 cm. long, 0.6–1 cm. wide, the petioles 2–4 mm. long; upper leaf-surfaces covered with minute white linear raphids, those of

the lower surface rather inconspicuous; pistillate inflorescence slender, longer than the leaves; achenes elliptic, 1 mm. long.

Sierra Maestra, Oriente (*Léon 10815*).

Pilea micromeriaefolia Britton & Wilson, sp. nov.

Stems elongate, woody, procumbent, the branches erect or ascending, 4-angled, scaly encrusted. Leaves in whorls of 3's or 4's, lanceolate, 0.8–1 cm. long, about 2 mm. wide, acute at the apex, obtuse at the base, glabrous, the petioles 1 mm. long or less; upper leaf-surfaces covered with linear raphides, those on the lower surface coarser; inflorescence not seen.

Brecha de Regino, Estribo Turquino, Oriente (*Léon 11008*).

Pilea yarensis Britton & Wilson, sp. nov.

An erect monoecious herb, 2–3.5 dm. high. Leaves membranous, broadly elliptic, acuminate at the apex, acute at the base, crenate-dentate, 3-nerved, glabrous above, often slightly pubescent on the midvein beneath, those of each pair unequal in size; larger leaves up to 15 cm. long, 6 cm. wide, with slender petioles sometimes 3.5 cm. long; smaller leaves up to 11 cm. long, 5 cm. wide, with petioles 1–2 cm. long; upper leaf-surface papillose, densely covered with linear raphides, those of the lower surface often indistinct; staminate inflorescence equalling or longer than the leaves, the peduncles sometimes 1 dm. long, the branches spreading, the perianth about 1.5 mm. long; pistillate inflorescence equalling or shorter than the leaves; achenes elliptic, 0.8 mm. long.

Bank of the Yara River, Sierra Maestra, Oriente (*Léon 10736*).

Pilea ermitensis Britton, sp. nov.

Stems slender, densely covered with linear raphides. Leaves oblong, oblong-lanceolate or elliptic, membranous, acute, entire, 3-nerved, glabrous, those of each pair unequal in size; larger leaves up to 3 cm. long, 6–7 mm. wide, with petioles 3 mm. long; smaller leaves 1–1.7 cm. long, 4–5 mm. wide, the petioles short; raphides of the upper leaf-surface minute, linear-filiform, those of the lower surface scattered, more conspicuous and stouter; inflorescence often shorter than the petioles, the flowers borne in globose heads 1.5–2 mm. in diameter; achenes elliptic-ovate, about 0.5 mm. long.

La Ermita, Oriente (*Hioram 4921*).

Pilea crenata Britton & Wilson, sp. nov.

Stem creeping, often rooting at the nodes, the branches erect or ascending, pilose. Leaves chartaceous, oval to suborbicular,

rounded at the apex, rounded or acute at the base, crenulate, 3-nerved, glabrous above, pilose on the nerves beneath, those of each pair often unequal in size; larger leaves up to 3 cm. long, 2.5 cm. wide, with slender petioles 1.5–2 cm. long; smaller leaves 1–2 cm. long, 1–2 cm. wide, the petioles 0.7–1 cm. long; upper and lower leaf-surfaces densely covered with linear raphides; pistillate inflorescence as long as or shorter than the leaves; achenes about 0.6 mm. long.

Sierra Maestra, Oriente (*Léon 10766*, type; *Léon, Clement and Roca 9872*).

Coccolobis monticola Britton, sp. nov.

Branches slender, glabrous; young twigs pubescent. Ocreae cylindric, 1 cm. long or less; leaves coriaceous, light green, 3–6 cm. long, reticulate-veined on both sides, shining above, dull and black-dotted beneath, the apex acute, the base obliquely obtuse, the petioles about 2 mm. long; racemes very slender, glabrous, densely many-flowered; ocreolae subtruncate, about 0.5 mm. long; pedicels glabrous, about 1 mm. long; calyx about 1 mm. long.

Sierra Maestra, Oriente (*Léon 10713*).

Coccolobis saxicola Britton, sp. nov.

A shrub about 3 m. high, glabrous throughout, the twigs short, stout, more or less tortuous. Ocreae subtruncate, 4–6 mm. long; leaves coriaceous, elliptic to obovate, 9 cm. long or less, the veins somewhat impressed above, prominent beneath, reticulate-veined on both sides, the apex abruptly short-acuminate, the base narrowed or obtuse, the petioles 5–15 mm. long; fruiting racemes slender, solitary, 6–9 cm. long; pedicels numerous, about 1.5 mm. long; ocreolae truncate, less than 1 mm. long, subpapillose, the sepals ovate.

On rocky crest in woods, Loma del Gato, Cobre Range of Sierra Maestra, Oriente (*Léon, Clement and Roca 10167*).

Talauma (?) **orbiculata** Britton & Wilson, sp. nov.

Tree 6–8 m. tall, with glabrous branches. Leaves orbicular, 8–12 cm. in diameter, rounded or subtruncate at the apex, rounded or truncate at the base, glabrous and prominently reticulate-veined on both sides, the midrib flat above, prominent beneath, the petioles rather slender, 3–6 cm. long, flat or shallowly grooved above, glabrous; sepals broadly elliptic, 2.6 cm. long, 2–2.3 cm. broad; petals thick, oblong or elliptic, about 2 cm. long, 0.8–1 cm. wide; carpels tomentulose.

Loma de Quintin, Nagua, Oriente (*Léon 10955*).

Persea anomala Britton & Wilson, sp. nov.

A shrub or tree, sometimes 10 m. tall, with appressed-pubescent twigs. Leaves lanceolate to ovate or elliptic, 4–10 cm. long or less, 1.8–5.5 cm. broad, rounded, obtuse, or acutish at the apex, rounded or somewhat acutish at the base, glabrous and reticulate-veined on both sides, the petioles slender, 1–1.8 cm. long; branches of the inflorescence pubescent with appressed hairs; calyx pubescent, greenish, its lobes unequal, the outer broadly ovate, about 1 mm. long, 0.7 mm. broad, the inner elliptic or broadly ovate, 1.7–2 mm. long, 1.5–1.7 mm. broad; berry subglobose, 11 mm. long, black.

Sierra Maestra, Oriente (*Léon 10707*, type; *10975; 10976; 10079; 11057*).

Persea similis Britton & Wilson, sp. nov.

Twigs appressed-pubescent. Leaves elliptic, 4–7 cm. long, acute or short-acuminate at the apex, acute at the base, dark green and glabrous above, the midvein impressed, paler beneath and pubescent with short appressed hairs, the lateral veins rather indistinct on both sides; petioles 3–4 mm. long; inflorescence pubescent with appressed brownish hairs; calyx-lobes elliptic to oval, 1.8 mm. long, about 1 mm. broad, appressed-pubescent.

Sierra Maestra, Oriente (*Léon 11058*).

Nectandra reticularis Britton & Wilson, sp. nov.

A shrub with pubescent twigs. Leaves elliptic-lanceolate, 3.5–6.8 cm. long, 1–2.3 cm. broad, acute to acuminate at the apex, acute at the base, glabrous, dark green, shining and reticulate-veined above, paler and reticulate-veined beneath; petioles 7 mm. long or less; inflorescence long-peduncled, the peduncle puberulent; flowers short-pedicelled; calyx white, its lobes elliptic, 1.5 mm. long, about 1 mm. broad, puberulent; drupe ellipsoid, about 1.1 cm. long, 6 mm. in diameter.

Sierra Maestra, Oriente (*Léon 10746*, type; *10958*).

Rubus turquinensis Rydberg, sp. nov.

Stem terete, 1–2 m. high, densely fuscous, villous-tomentose and with numerous stalked glands, armed with somewhat compressed curved pubescent prickles 4–8 mm. long; leaves of the branches 3-foliolate, those of the main stem not seen; petiole and ribs of the leaflets villous-tomentose, glandular, and slightly prickly; petiolule of the terminal leaflet 7–15 mm. long, those of the lateral leaflets 1–4 mm. long; leaflets lanceolate, long-acuminate, mostly rounded at the base, finely and closely serrate,

3–10 cm. long, dark-green, sparingly pubescent and somewhat glandular-granuliferous above, paler and somewhat fuscous and densely short-villous, almost subvelutinous, beneath; racemes 3–6 cm. long, 5–10-flowered; peduncles and pedicels densely pubescent and glandular, slightly prickly; sepals lanceolate, acuminate, 5–6 mm. long, glandular and pubescent without, grayish-tomentose within; berry about 1 cm. long and 7–9 mm. thick; drupelets many, glabrous.

Type collected on the top of Pico Turquino, Oriente, Cuba, July 23, 1922, *Léon 10755* (New York Botanical Garden); also at an altitude of 1600 m. on the same mountain, *10756*.

R. turquinensis is a member of the *Adenotrichi*, differing from *R. costaricanus* and *R. adenotrichos* in the narrower lanceolate long-acuminate, instead of broadly ovate, abruptly acuminate leaflets; from *R. Vera-Crucis* in the more dense pubescence and the texture of the leaves. It is more closely related to *R. irasuensis* and *R. miser*. In habit, leaf-form, and pubescence it resembles the former, but the inflorescence is mostly simple, the sepals narrower, and the drupelets perfectly glabrous; neither have any 5-foliolate leaves been seen. From *R. miser* it differs in the shorter sepals and the thicker leaflets, with shorter petioles, more numerous and more prominent lateral veins, and much closer serrations.

Polygala scabridula Blake, sp. nov.

Virgate leafy shrub 2–3 m. high, the branches erect, hispidulous. Petioles hispidulous, 2 mm. long; leaf blades obovate, 1.3–1.8 cm. long, 9–12 mm. wide, broadly rounded at apex, rounded or cuneate-rounded at base, coriaceous, scabrid-hispidulous above with persistent ascending hairs, similarly pubescent beneath; racemes axillary, the axis few-flowered, about 1 mm. long, the peduncle obsolescent; pedicels glabrous, 1.2 mm. long; flowers immature; sepals deltoid-ovate, ciliolate, obtuse, 1.1 mm. long; wings similar, 1.4 mm. long and wide; keel ciliate, otherwise subglabrous, 2.5 mm. long; capsule subquadrate, rather broadly margined, slightly wider at the apex, ciliolate, otherwise glabrous, 6 mm. long, 8.5 mm. wide, lobed for about 1/3 its length; seed ellipsoid, sparsely pubescent, 4 mm. long; aril orange, 1.8 mm. deep, with repand lateral margin, the dorsal lobe 1 mm. long.

Sabana de Motembo, Santa Clara, August 9–10, 1920 (*Léon and Loustalot 9333*).

This species is related to *Polygala portoricensis* (Britton) Blake, of Porto Rico, which has larger emarginulate leaves, and a smaller, less deeply lobed capsule.

Polygala rhynchosperma Blake, sp. nov.

Slender erect annual, 14–25 cm. high, simple or few-branched above, evenly but not densely puberulous with short, thickish, incurved or subappressed eglandular hairs. Leaves alternate except for 1 or 2 basal whorls, rather crowded, short-petioled, the blades linear, 6–14 mm. long, 0.5–1.3 mm. wide, acute, cuspidulate, 1-nerved, sparsely puberulous like the stem, erect; peduncles 5–15 mm. long; racemes slender, cylindric, gradually narrowed to an obtuse apex, loose below, 2–9 cm. long, the axis becoming 10.5 cm. long and more, puberulous like the stem; bracts oval or obovate, caducous, 1.5 mm. long, puberulous at base, with rather short abrupt caudate purplish tips; pedicels glabrous, 1 mm. long, clavellate; sepals pinkish white with greenish center, glabrous, the upper oval-ovate, obtuse, 1.5 mm. long, the 2 lower oblong, obtuse, 1.2–1.5 mm. long, sometimes obscurely 1-denticulate on each side near apex; wings pinkish (when dried), obovate, 3 mm. long, 1.5 mm. wide, rounded or obtuse, scarcely clawed, 3-nerved; upper petals slightly shorter than keel, the free portion obliquely ovate, obtuse, 3-nerved; keel 3–3.2 mm. long, slightly surpassing the wings, the crest on each side of a deeply trifid lamella and a 2- or 3-fid or 2-parted lobe with linear segments; capsule pendulous at maturity, slightly surpassing the wings, elliptic-oblong, emarginate, 3.3 mm. long, 1.5 mm. wide; seeds subcylindric, 2.2 mm. long, densely short-pilose, distinctly rostrate at base (beak conic, 0.4 mm. long); aril fastened to upper half of beak, 0.7 mm. long, the 2 lobes rhombic, acute or obtuse, appressed; stigma with short blunt retrorse lower lobe and substipitate penicillate upper lobe.

Sabana del Cerro, near Zarzal, Oriente, July, 1922 (*Léon 10990;* type No. 1,049,981, U. S. National Herbarium).

Among North American species *Polygala rhynchosperma* is nearest *P. paniculata* L., which is densely stipitate-glandular and has shorter wings and an erostrate seed. The Venezuelan *P. Funkii* Chod., known to me only from Chodat's description and figures, is evidently closely related, having similar bracts, seed, and stigma. It is described as glabrous, with acute lance-elliptic sepals, acute wings, and a crest composed on each side of an acute triangular entire lamina and an undivided linear lobe.

Polygala ambigens Blake, sp. nov.

Stems usually solitary from a slender but evidently perennial root, simple or sparsely branched, 3.5–6 dm. high, very slender, glabrous throughout or sparsely incurved-puberulous on the

younger parts; leaves alternate, linear or linear-filiform, 9–25 mm. long, 0.5–1.5 mm. wide, cuspidulate, short-petioled, 1-nerved, the margins often inflexed; peduncles 5–10 mm. long; racemes loosely many-flowered, the axis sometimes becoming 25 cm. long; bracts subulate, 1.5 mm. long, caducous; pedicels glabrous, 1.5–2 mm. long; sepals bearing 3–6 pairs of stipitate glands, sometimes also ciliolate with eglandular hairs toward apex, the upper sepal 2 mm. long, the lower sepals (connate nearly to apex) 1.5 mm. long; wings magenta-purple, broadly and obliquely cuneate-obovate, 3.8–4.5 mm. long, 2.8–3.2 mm. wide, subsessille or short-clawed, emarginate at apex, glabrous, about 5-veined, the veins loosely anastomosing, not at all prominulous; upper petals magenta-purple; keel yellow-tipped, becoming 4 mm. long; capsule 3.8 mm. long, 2.4 mm. wide, slightly shorter than the mature wings; seed densely pilose, 2.8 mm. long; aril sparsely pubescent on the sides, 0.8 mm. high.

Sabana del Cerro, near Cerro Pelado, between Zarzal and Nagua, Oriente, July, 1922 (*Léon 10860;* type No. 1,049,889, U. S. National Herbarium).

Nearly related to *Polygala cubensis* Chod., which is an annual with shorter sepals (1.1–1.3 mm. long), and somewhat smaller wings shorter than the capsule. In its slender but evidently perennial root resembling *P. Wrightii* Chod., which is densely incurved-puberulous and has the sepals ciliate with eglandular hairs. Much more material of the Cuban representatives of this group (section *Adenotricha* of subgenus *Hebeclada*) must be accumulated before the specific characters can be established satisfactorily.

Maytenus saxicola Britton & Wilson, sp. nov.

A glabrous shrub, 4 m. high, with rather stiff, somewhat flexuose twigs. Leaves elliptic to elliptic-ovate, rigid-coriaceous, 3–6 cm. long, 1.5–3.3 cm. broad, obtuse or rounded at the apex, acute at the base, dark green above, paler beneath, the midvein elevated on both sides, the lateral veins often rather indistinct, the margin minutely crenulate; petioles 5 mm. long or less; pedicels slender, up to 7 mm. long; capsule globose-obovoid, 8 mm. long, 7–8 mm. in diameter.

On rocks, Sierra Maestra, Oriente (*Léon, Clement and Roca 10221*).

Rhamnidium bicolor Britton & Wilson, sp. nov.

A shrub, with slender puberulent twigs. Leaves opposite, elliptic or ovate-elliptic, 8 cm. long or less, repand-crenate, mem-

branous, the apex acuminate, the base rounded or subtruncate, the venation ascending, densely and finely reticulate-veined on both sides, the upper surface green and glabrate, the under side whitish puberulent, the petioles 6–10 mm. long; stipules obliquely linear-lanceolate, nearly as long as the petioles; inflorescence axillary, glabrous; peduncles nearly as long as the petioles; flowers subglomerate; pedicels very short; sepals triangular-ovate, 2.5 mm. long, acute, glandular-dotted; petals orbicular-obovate, 1.5 mm. long, about 1.5 mm. broad.

High Sierra Maestra, Oriente (*Léon 11025*). Other specimens from the Sierra Maestra (*Léon 10952*), in foliage only, have entire leaves, somewhat larger, and may represent another species.

Ouratea xolismaefolia Britton & Wilson, sp. nov.

A glabrous shrub, with slender terete twigs. Leaves oblong, elliptic, or elliptic-obovate, coriaceous, 3 cm. long or less, the midvein prominent, the lateral venation delicate and nearly obscure, the apex rounded or emarginate, the base narrowed or cuneate, the petioles 1–2 mm. long; pedicels slender, 5–6 mm. long, sepals elliptic to oval, 3 mm. long; petals obovate, 4–4.5 mm. long, 3 mm. broad, rounded or truncate at the apex; anthers 3 mm. long.

High Sierra Maestra, Oriente (*Léon 10911*).

Taonabo monticola Britton & Wilson, sp. nov.

A glabrous shrub, 1 m. or more tall, with light brown twigs. Leaves elliptic-obovate, rigid-coriaceous, 2–5 cm. long, 1.3–2.5 cm. broad, rounded at the apex, acute at the base, indistinctly veined, the midvein impressed above; petioles 4 mm. long; peduncles 2–3 cm. long; sepals 5, the outer oval to suborbicular, 5.5–6 mm. long, 5–5.5 mm. broad, glandular-ciliate, the inner 4.5–5 mm. broad, rigidly and sharply acute, without marginal cilia; fruit (immature?) ovoid, 9.5 mm. in diameter.

Sierra Maestra, Oriente (*Léon 10839*, type; *10837; 11193*).

Taonabo Leonis Britton & Wilson, sp. nov.

A glabrous shrub, with light-gray twigs. Leaves obovate, 2.5–5 cm. long, 1.4–2.7 cm. broad, rounded or truncate and often slightly emarginate at the apex, acute at the base, indistinctly veined, dark green above, paler beneath, the petioles 2–3 mm. long; peduncles 3–7 mm. long, reflexed; sepals 5, the outer oval, 4.7–5 mm. long, 4 mm. broad, rounded at the apex, glandular-ciliate, the inner elliptic, 3–3.5 mm. long, acute, without glandular cilia.

Vicinity of Pico Turquino, Oriente (*Léon 10910*).

Haemocharis angustifolia Britton & Wilson, sp. nov.

A tree 20–30 m. tall, with slender grayish brown twigs, pubescent with strigillose hairs. Leaves oblong or oblong-obovate, 2–5.5 cm. long, 0.5–1.3 cm. broad, obtuse or rounded at the apex, acute at the base, light green and glabrous above, paler beneath and pubescent; flowers about 3 cm. in diameter; sepals oval or suborbicular, 4.5–6 mm. long, 4–6 mm. broad, pubescent on the back with appressed hairs; petals obovate, 1.2–1.3 cm. long, 6–7 mm. broad, rounded at the apex, pubescent; filaments filiform, glabrous; ovary villous.

Sierra Maestra, Oriente (*Léon, 11072*).

Begonia lomensis Britton & Wilson, sp. nov.

Suffruticose, the stems 3–4.5 dm. high, rusty pilose. Leaves obliquely cordate-ovate to obliquely suborbicular, 1.5–4 cm. long, 1–2.7 cm. wide, acute, glabrous above at maturity, rusty pilose or nearly glabrous beneath, coarsely toothed, the petioles 4–20 mm. long, pilose; stipules lanceolate, acuminate, entire, 4–6 mm. long, 1.5–2 mm. broad; inflorescence long-peduncled; staminate flowers; pedicels slender, up to 7.5 mm. long, glabrous; sepals 2, orbicular, 7–8 mm. long, 8–9 mm. wide; petals 2, obovate, 4 mm. long, 3 mm. wide; stamens 20 or more; capsule long-pedicelled, the body 8–9 mm. long, 5–6 mm. wide, the wing about 9 mm. broad, obtuse or acutish.

Farallones de la Loma Regino, Oriente (*Léon 10731*).

Ginoria montana Britton & Wilson, sp. nov.

A glabrous unarmed shrub, with slender ascending branches. Leaves lanceolate, coriaceous, 2.5–4.3 cm. long, 0.7–1.7 cm. broad, obtuse at the apex, acute at the base, faintly reticulate-veined; petioles slender, 2 mm. long; cymes sessile or nearly so; flowers immature, long-pedicelled; calyx-lobes spreading, appendaged below the sinuses; stamens about 20.

Sierra Maestra, Oriente (*Léon 11009*).

Psidium (?) **cacuminis** Britton & Wilson, sp. nov.

Glabrous, with straight slender twigs. Leaves oblong,thick-coriaceous, 4–7 cm. long, reticulate-veined, sparingly punctate, bright green and shining above, pale green beneath, the apex rounded or obtuse, the base narrowed, the stout petioles about 6 mm. long; fruit oblong, solitary and nearly sessile in upper axils, nearly 2 cm. long.

Pico Turquino, Oriente (*Léon 10749*).

Calyptranthes montana Britton & Wilson, sp. nov.

A much-branched shrub, with slender glabrous branches, the twigs rusty-brown and somewhat pubescent when young. Leaves lanceolate, coriaceous, 9–30 mm. long, 6–11 mm. broad, obtusely acuminate at the apex, acute at the base, rusty brown and pubescent when young, glabrous at maturity, the lateral veins rather prominent on both sides; petioles 0.9 mm. long or less; inflorescence 1–3-flowered, the peduncles filiform, 7 mm. long or less; buds globose-ovoid, 1.5 mm. in diameter.

Sierra Maestra, Oriente (*Léon 10805*).

Eugenia cati Britton & Wilson, sp. nov.

A glabrous shrub or small tree, the twigs slender. Leaves elliptic to elliptic-obovate, chartaceous, 7 cm. long or less, rather sparingly punctate, dark green above, pale beneath, not very conspicuously veined, the apex rounded or obtuse, the base mostly narrowed, the petioles 3–7 mm. long; flowers glomerate in the axils; calyx-lobes suborbicular, about 3 mm. broad.

In woods, Loma del Gato, Cobre Range of Sierra Maestra, Oriente (*Léon, Clement and Roca 10045*, type; *10588*).

Eugenia ginoriaefolia Britton & Wilson, sp. nov.

Glabrous; twigs slender. Leaves ovate to elliptic, chartaceous, 3–7 cm. long, dark green and shining above, rather prominently veined, pale beneath, densely punctate, the apex obtuse, the base obtuse or narrowed, the petioles only 3 mm. long or less; flowers glomerate at the nodes of twigs, sessile; calyx-lobes about 2 mm. broad, densely glandular, glabrous; petals elliptic to oval, about 3 mm. long, 1.8–2.2 mm. broad, obtuse or acutish at the apex; filaments filiform, glabrous, the anthers elliptic.

Sierra Maestra, Oriente (*Léon 10812*).

Eugenia lomensis Britton & Wilson, sp. nov.

Shrub 2–3 m. high, with slender pubescent twigs. Leaves lanceolate or elliptic, coriaceous, 3.5–7 cm. long, 1.7–3 cm. broad, acuminate at the apex, acute at the base, glabrous or nearly so above, the midrib and lateral veins impressed, pubescent beneath, the midvein prominent; petioles 2.5 mm. long or less; fruit subglobose, 9 mm. in diameter, black, slender-peduncled, solitary or clustered in the axils of the leaves.

Foothills of the Sierra Maestra, Oriente (*Léon 10794*, type; *10962*).

Eugenia brevipetiolata Britton & Wilson, sp. nov.

A glabrous shrub, with rather thick brownish gray twigs. Leaves oval to suborbicular, 5–8 cm. long, 4–6.5 cm. broad, rounded at both ends, dark yellowish green above, paler beneath, the midrib impressed above, prominent beneath, the lateral veins slender, slightly elevated on both surfaces; petioles stout, 2–3 mm. long; buds subglobose, 6 mm. in diameter, solitary or few together in the axils of the leaves, glabrous.

Sierra Maestra, Oriente (*Léon 11046*).

Eugenia rigidula Britton & Wilson, sp. nov.

Shrub 1 m. tall, with slender brownish pubescent twigs. Leaves lanceolate to ovate-lanceolate, rigid-coriaceous, 1–2.8 cm. long, 4–11 mm. broad, acute at the apex, rounded at the base, sparingly pubescent on both sides when young, glabrous at maturity, the petioles 1 mm. long or less; young fruits subglobose, 4–5 mm. in diameter, pubescent with appressed whitish hairs.

Edge of woods, Sierra Maestra, Oriente (*Léon, Clement and Roca 10634*).

Anamomis reticulata Britton & Wilson, sp. nov.

Shrub or tree, the young twigs slender, brown, puberulent, the branches gray. Leaves obovate, coriaceous, 3–4.5 cm. long, 1–2.5 cm. broad, rounded at the apex, cuneate at the base, yellowish-green above, paler beneath, sparingly pubescent on both sides when young with short appressed hairs, glabrous at maturity, reticulate-veined; branches of the inflorescence appressed-pubescent; flowers undeveloped.

Sierra Maestra, Oriente (*Léon 10968*).

Graffenrieda rufescens Britton & Wilson, sp. nov.

Shrub 3 m. tall, the branches, twigs, calyx and under surface of the leaves densely scurfy with brownish scales. Leaves elliptic, 4.5–10 cm. long, 2.4–4 cm. wide, acuminate at the apex, acute at the base, 3-nerved, dark green and glabrous above, the petioles 1–2 cm. long; inflorescence much-branched; flowers short-pedicelled; calyx-tube 3–3.5 mm. long, 8-ribbed, its lobes semiorbicular, 1 mm. long or less; petals suborbicular or orbicular-obovoid, 3.5 mm. long, 3–3.5 mm. wide, yellow.

Sierra Maestra, Oriente (*Léon 11047*).

Miconia plumieriaefolia Britton & Wilson, sp. nov.

Shrub, the twigs, petioles and branches of the inflorescence clothed with a dense brownish white stellate scurf. Leaves

3-nerved, oblong or oblong-lanceolate, coriaceous, 10.5–15 cm. long, 2.5–3.8 cm. broad, green and glabrous or nearly so above, densely ferruginous-pubescent beneath with short stellate hairs, reticulate-veined, the lateral veins 2–3 mm. distant, nearly at right angles to the midrib, the petioles 1.5–2 cm. long; branches of the inflorescence loosely articulate; pedicels 2–4.5 mm. long; flowers undeveloped; calyx-lobes shortly triangular-ovate.

Sierra Maestra, Oriente (*Léon 10925*).

Rapanea microphylla Britton & Wilson, sp. nov.

A glabrous shrub, with short and slender twigs. Leaves obovate or oblong-obovate, coriaceous, 8–20 mm. long, pinnately few-veined, punctate, the apex rounded, the base connate, the petioles 2–3 mm. long; fruits nearly sessile, subglobose, shining, about 3 mm. in diameter.

Pico Turquino, Sierra Maestra, Oriente (*Léon 10714*).

Symplocos Leonis Britton & Wilson, sp. nov.

Shrub, the twigs dark brown, strigillose. Leaves elliptic, subcoriaceous, 4–8.5 cm. long, 2–4 cm. broad, rounded or obtusely acute at the apex, acute at the base, dark green, glabrous and indistinctly reticulate-veined above, the midrib impressed, paler, reticulate-veined and pubescent with appressed hairs especially on the midvein beneath, or nearly glabrous; petioles about 5 mm. long; inflorescence pubescent with ferruginous hairs; calyx-lobes elliptic, 1.4 mm. long, 0.9 mm. broad; petals 5, broadly oval, 3–3.5 mm. long, 2.5 mm. broad, glabrous; filaments distinct nearly to the base; fruit ellipsoid, 8.5 mm. long, 5.5 mm. in diameter, pubescent with scattered appressed hairs.

Sierra Maestra, Oriente (*Léon 10738*, type; *10907*).

Plumiera montana Britton & Wilson, sp. nov.

A tree up to 10 m. high or higher, glabrous throughout. Leaves oblanceolate, 15 cm. long or less, membranous when dry, the lateral venation rather widely spreading, the apex rounded, the base cuneate, the slender petioles 1–3 cm. long; flowers several or numerous; pedicels rather stout, 1.5 cm. long or less; calyx about 5 mm. long; corolla (white?) its slender tube about 2 cm. long, about one-half as long as the narrowly oblanceolate, rounded lobes; pod about 12 cm. long.

Sierra Maestra, Oriente. Type from banks of Yara River (*Léon 11060*).

Marsdenia bicolor Britton & Wilson, sp. nov.

A slender vine, with puberulent stems. Leaves oblong-elliptic to elliptic, 5–6.5 cm. long, 1.5–3.2 cm. broad, green above, whitish beneath, glabrous on both surfaces, the lateral veins indistinct; calyx-lobes ovate, 4 mm. long, about 2 mm. broad, acute or acuminate, slightly pubescent; corolla 1.5 cm. long, 1.5–1.8 cm. wide, glabrous, its lobes triangular, 6 mm. long, 5.5–6 mm. wide.

Sierra Maestra, Oriente (*Léon 10787*, type; *10788*).

Sebesten Leonis Britton & Wilson, sp. nov.

A tree up to 15 m. high, the young twigs sparingly pubescent, soon glabrous and gray. Leaves thick-coriaceous, glabrous or the short and stout petioles sparingly pubescent, shining, elliptic, oblong or obovate-elliptic, 5–9 cm. long, the venation impressed above, prominent beneath, the apex rounded, the base obtuse or rounded, the petioles only 8 mm. long or less, the upper surface dark green, the under surface light green; flowers several in terminal clusters; calyx subcylindric, nearly 2 cm. long, densely puberulent, its teeth very short and broad; corolla funnelform, its tube about 3 cm. long, enlarged upward, the widely spreading limb about 4 cm. broad, about 6-lobed; fruit ovoid, about 2 cm. long, its summit beaked.

Loma de Naranjo, Sierra Maestra, Oriente, at 600 m. elevation (*Léon 11021*).

Varronia longipedunculata Britton & Wilson, sp. nov.

A shrub with slender branches, the young twigs puberulent. Leaves elliptic or oblong, chartaceous, 7 cm. long or less, scabrate above, puberulent on the veins beneath, entire or sparingly repand, the apex obtuse or acute, the base mostly narrowed, the puberulent petioles 6–12 mm. long; peduncles solitary, slender, puberulent, longer than the leaves; flowers several in a terminal globose head about 1.5 cm. in diameter; calyx-lobes triangular, 1.5 mm. long, acute; corolla-lobes broadly obovate, 7.5 mm. long, 4.5 mm. broad.

Sierra Maestra, Oriente (*Léon 10964*).

Salvia scopulorum Britton & Wilson, sp. nov.

A shrub, about 3 m. high, the branches densely pubescent with short spreading hairs. Leaves ovate, coriaceous, crenulate, 3–5 cm. long, 1.5–3 cm. broad, acute to abruptly short-acuminate at the apex, rounded and often more or less subcordate at the base, dark green above, paler beneath, pubescent on both sides, the

petioles 12 mm. long or less; calyx 10–11 mm. long, finely pubescent; corolla red, 1.8 cm. long or more, pubescent.

Farallones de Regino, Estribo Turquino, Oriente, 1600 m. alt. (*Léon 11010*).

Rondeletia naguensis Britton & Wilson, sp. nov.

A shrub about 2 m. high, the young twigs and inflorescence densely strigose. Leaves elliptic, subcoriaceous, 4–10 cm. long, sparingly strigose on the veins beneath when young, soon glabrous, the apex obtuse or acute, the base obtuse or narrowed, the venation inconspicuous, the strigose petioles 6–12 mm. long; flowers in peduncled heads, the peduncles 2–4 cm. long; bractlets obovate, about 3 mm. long; calyx-lobes oblanceolate, 3.5–4 mm. long, densely pubescent with appressed hairs; capsule subglobose, 5.5 mm. in diameter, appressed-pilose.

Banks of a stream, Loma de Quintin, Nagua, Oriente (*Léon 10971*).

Rondeletia calophylla Standley, sp. nov.

Branchlets slender, pilose-strigose; stipules deltoid-acuminate, 1.5 to 2.5 mm. long, erect, persistent; petioles stout, 2 mm. long, strigillose; leaf blades ovate, sometimes broadly so, 2 to 3.5 cm. long, 1 to 2.5 cm. wide, acute or sometimes obtuse, broadly rounded or subcordate at base, thick-coriaceous, dark green above, lustrous, scaberulous or glabrate, the venation prominulous-reticulate, much paler beneath and brownish, glabrate or scaberulous along the nerves, the costa prominent, the lateral nerves few and distant; inflorescence terminal on the main branches and on leafy lateral twigs, few-flowered, lax, the flowers pedicellate; calyx globose, densely whitish-strigillose; calyx lobes 5, oblong or linear-oblong, 2 mm. long, obtuse, glabrate, suberect; corolla densely white-strigillose outside, the tube 4 mm. long, the 5 lobes rounded, 2 mm. long; capsule subglobose, 3–4 mm. broad, glabrate; seeds broadly winged.

Type (in the U. S. National Herbarium) collected in the Sierra Maestra, Oriente, July, 1922, (*Léon 10741*).

In the key to the species of *Rondeletia* in the North American Flora, this plant runs at once to the group *Odoratae*, but it is not closely related to any of the species placed there, or to any other Cuban species previously known to the writer.

Guettarda cryptantha Standley, sp. nov.

Shrub, the branches grayish, the branchlets slender, densely pilose with subappressed fulvous hairs; stipules 8–10 mm. long,

oblong-lanceolate, long-acuminate, appressed-pilose; leaves opposite, the petioles stout, 2–3 mm. long, appressed-pilose, the blades elliptic or ovate-elliptic, 2.5–6 cm. long, 1.2–3 cm. wide, rounded at base, obtuse or rounded at apex, coriaceous, dark-green above, lustrous, at first pilose with very slender whitish appressed hairs but later glabrate, the venation depressed, paler and brownish beneath, thinly scaberulous-pilosulous and with longer subappressed hairs along the veins, the costa stout and prominent, the lateral veins 5–7 pairs, subarcuate, anastamosing, remote from the revolute margin; inflorescence few-flowered, closely sessile, terminal and axillary, subtended by large, densely pilose, oval bracts; hypanthium densely sericeous-pilose with long whitish hairs, the calyx 5–7 mm. long, cleft into 3 or 4 spatulate-obovate, obtuse, densely sericeous lobes; corolla brownish-red, the tube stout, 10–12 mm. long, densely pilose with long whitish ascending hairs, the 4 lobes rounded-oval, 4 mm. long, glabrous within.

Type collected on Loma del Gato, Cobre Range of Sierra Maestra, Oriente, altitude 900–1000 meters (*Léon, Clement and Roca 10301;* herbarium of the New York Botanical Garden).

Guettarda cobrensis Standley, sp. nov.

Shrub 3 meters high, the branches dark reddish brown, the branchlets thick, densely covered with minute appressed fulvous hairs, the internodes short; stipules oblong-ovate, 4 mm. long or more, acuminate, thin, brown, pubescent like the branchlets and with few long subappressed hairs; leaves opposite, the petioles stout, 4–6 mm. long, minutely and densely appressed-pilose, the blades oval or broadly oval, 3–6 cm. long, 2–4.5 cm. wide, rounded at apex, deeply cordate at base, thick-coriaceous, yellowish-green, concolorous, often somewhat bullate, glabrous above, the venation depressed, beneath bearing a few short appressed hairs along the coarse prominent costa, but elsewhere glabrous, the lateral veins stout and prominent, 5 or 6 on each side, subarcuate, ascending at an angle of 45–60°, the intermediate veins inconspicuous, the margin subrevolute; peduncles about 1 cm. long, pubescent like the branchlets, the flowers usually 3, sessile; fruit globose, 1 cm. in diameter, minutely tomentulose.

Type collected at edge of woods, Loma del Gato, Cobre Range of Sierra Maestra, Oriente, altitude 800 meters (*Léon, Clement and Roca 10271;* herbarium of the New York Botanical Garden).

Related to *G. crassipes* Britton, in which the leaves are densely long-pilose beneath along the costa.

Stenostomum apiculatum Britton & Standley, sp. nov.

Branchlets thick, resinous, densely leafy, sericeous-strigose; stipules united, persistent, the sheath 5 mm. long, densely strigose; petioles stout, 5–12 mm. long, densely strigillose; leaf blades elliptic, 4.5–7 cm. long, 2.5–4 cm. wide, obtuse or acute at base, obtuse at apex and apiculate-acuminate, coriaceous, green above, lustrous, glabrous, the costa depressed, paler beneath and brownish, sparsely strigillose, the veins prominent, the lateral ones about 9 pairs, arcuate, distant, the margin plane or subrevolute; peduncles slender, about 3 cm. long, the 2 branches 2–2.5 cm. long, 10–12-flowered; calyx and hypanthium 1–1.5 mm. long, glabrate, the calyx with very short, obtuse teeth; corolla 7 mm. long, densely strigillose outside; filaments very short, the anthers oblong-linear, equaling the corolla tube; stigma 4-lobate.

Type (in the U. S. National Herbarium) collected in the Sierra Maestra, Oriente, July, 1922 (*Léon, 10806.*)

Psychotria Leonis Britton & Wilson, sp. nov.

Shrub, the twigs and branches of the inflorescence puberulent. Leaves elliptic to oval, 3–5 cm. long, 1.5–3 cm. broad, acute to short-acuminate at the apex, acute at the base, glabrous above, pubescent beneath when young with short appressed hairs, the primary veins indistinct above, prominent beneath; petioles 1.3–1.5 cm. long, puberulent; panicles few-flowered; calyx funnel-shaped, shallowly toothed, the teeth triangular, acute; buds narrowly ellipsoid, puberulent; mature flowers and fruits not seen.

Sierra Maestra, Oriente (*Léon 10789*).

Lobelia cacuminis Britton & Wilson, sp. nov.

Suffrutescent, the stems 3–4 m. high, nearly glabrous. Leaves chartaceous, oblanceolate, 7–13 cm. long, 2.5–4.5 cm. wide, acuminate at the apex, cuneate at the base, rather coarsely dentate, the petioles 1.5–3 cm. long; midrib flat above, prominent beneath, the lateral veins ascending; inflorescence many-flowered; pedicels slender, 10–12 mm. long, pubescent; calyx-lobes narrowly lanceolate, 3–4 mm. long; mature corolla not seen; young fruits 1 cm. in diameter.

Pico Turquino, Oriente (*Léon 10862*).

Senecio Leonis Britton & Wilson, sp. nov.

Vine, the slender stems glabrous. Leaves ovate, triangular-ovate or occasionally lanceolate, 1.5–4.5 cm. long, 0.9–2.7 cm. wide, often with one or more prominent teeth at or above the

base, palmately-veined, glabrous on both sides; petioles 0.5–1.5 cm. long; heads long-peduncled, the peduncles pubescent; involucre subcylindric-campanulate, 5–6 mm. high, its bracts oblong, glabrous, their tips acute or acuminate; pappus white, 4 mm. long; achene about 1 mm. long.

Climbing on shrubs, Loma del Sabicu, Oriente (*Léon 10751*).

Chaptalia montana Britton, sp. nov.

Leaves oblanceolate-spatulate, thin, 4–7 cm. long, lyrate-pinnatifid, the terminal lobe large, elliptic-obovate, obtuse, apiculate, the lateral ones few, small, rounded, the upper surface green and glabrate, the under grayish-lanate; scape filiform, 1.5–2.5 dm. long; head erect; involucre subcampanulate, its bracts linear, acuminate, lanate below, the inner ones about 7 mm. long; achenes fusiform, 5.5–6 mm. long, the slender beak longer than the body; pappus white.

Sierra Maestra, Oriente (*Léon 10802*).

65. UNDESCRIBED SPECIES FROM TRINIDAD

Bactris savannarum Britton, sp. nov.

Trunk slender, up to 10 m. high, erect, copiously armed, like the leaf-rachis, with nearly white, deflexed spines 1–5 cm. long, which turn darker in age. Leaves about 1 m. long or longer, petioled, the numerous, unarmed segments 2–4 dm. long, about 4 cm. wide or less, light green, paler beneath than above, the base attenuate, the apex acuminate or acute, some of the upper ones of young leaves confluent; spathe narrowly oblong, 2–3 dm. long-acuminate, densely appressed-bristly, the bristles rather soft; inflorescence about as long as the spathe, its axis and slender branches densely brown-villous; flowers numerous, nearly white, about 4 mm. long; fruit orange, depressed-globose, small for the genus, about 8 mm. in diameter, vertically striate; fruiting calyx nearly flat, about 5 mm. broad, its lobes rounded, striate.

Aripo Savanna and its forest borders, Trinidad (*Britton, Broadway and Hazen 269*, type; Trinidad Herbarium *9850, Broadway*); Professor L. H. Bailey has kindly sent us two photographs of this palm taken by him in 1921.

Pilea aripoensis Britton, sp. nov.

Stems filiform, 4–7 cm. long. Leaves membranous, spatulate, entire, 1-nerved, 12 mm. long or less, the apex rounded, the base cuneate, the filiform petiole somewhat shorter than the blade,

the raphides linear, undulate, transverse, prominent upon the upper surface.

Hanging from wet dark banks, Heights of Aripo, Trinidad (Trinidad Herbarium *10,008, Broadway*).

Inga ierensis Britton, sp. nov.

A tree up to 16 m. high, the petioles, leaf-surfaces and peduncles strigillose. Petioles slender, 2–3 cm. long; rachis-glands suborbicular, semiglobose; leaflets in 2 pairs, ovate-elliptic, chartaceous, shining, 7–10 cm. long, pinnately veined, the apex rather abruptly short-acuminate, the oblique base narrowed or obtuse, the strigulose petiolules 2–3 mm. long; peduncles about 6 cm. long or less; legume broadly linear, compressed, glabrous, shining, up to 10 cm. long, about 2 cm. wide, finely striate, abruptly short-tipped, the margins continuous or deeply constricted.

Forests, northern mountain range, Trinidad. Type from the Maracas Valley (*Britton and Hazen 1627*). In fruit April 10, 1920.

Serjania ierensis Britton, sp. nov.

A vine up to 7 m. long, the branches slender, glabrous. Leaves about 6 cm. long, biternate, the short, slender petioles 1.5 cm. long or less, sparingly pubescent; leaflets coriaceous, glabrous, 4 cm. long or less, serrate, finely reticulate-veined, shining, those of the terminal segment acute or acuminate, those of the lateral segments rounded or obtuse; peduncles about as ong as the leaves, glabrous; tendrils very slender, 2–4 cm. long; panicles puberulent nearly as long as the peduncles; samaras glabrous, about 15 mm. long, the wing finely reticulate-veined, about 4 times as long as the body and only partially enclosing it.

Dry thickets, Trinidad. Type from Palo Seco (*Britton and Hazen 1172*). In fruit March 30, 1920.

Clusia intertexta Britton, sp. nov.

Forming impenetrable masses with interlocking aerial roots. Leaves orbicular-obovate, 10–14 cm. long, thick-coriaceous, rounded, the base subcuneate, the lateral veins many, about 4 mm. apart, prominent on the upper surface, the very stout petioles 1 cm. long or less; inflorescence several-flowered, its branches stout; bracts 2–3 cm. long; buds globose, glabrous; fruit (immature) oblong-ovoid, beaked, about 2.5 cm. long; stigmas 6.

Forest, Heights of Aripo, Trinidad (Trinidad Herbarium *9786, Broadway*), January 10–26, 1922.

Clusia aripoensis Britton, sp. nov.

A tree, with slender twigs. Leaves narrowly obovate, subcoriaceous, 7–8 cm. long, the apex obtuse, the base cuneate, the rather closely pinnate venation prominent on the under side, almost wholly obscure above, the rather slender petioles 1–2 cm. long, stigmas 5; young fruit obovoid, 2.8 cm. long, 2 cm. in diameter.

Forest, Heights of Aripo Trinidad (Trinidad Herbarium *9785*, *Broadway*), January 10–26, 1922.

Stylogyne tenuifolia Britton, sp. nov.

A tree up to about 10 m. in height. Leaves elliptic, membranous, 8–20 cm. long, glabrous, the base narrowed, the apex rather abruptly acuminate, the midvein impressed above, prominent beneath, the stout petioles 5–12 mm. long; inflorescence lateral and terminal, 5 cm. long or less, short-paniculate; bractlets oblong-lanceolate, 2–3 mm. long, deciduous; pedicels nearly filiform, 5–10 mm. long; calyx-segments broadly ovate, rounded, about 2 mm. long; corolla about twice as long as the calyx; fruit globular, white, 6–7 mm. in diameter.

Forests at higher elevations in the northern mountain range, Trinidad. Type from Mt. Tocuche (*Britton, Hazen and Mendleson 1341*); collected also by Mr. Broadway on the Heights of Aripo (Trinidad Herbarium, *9837*, *9840*).

Prestonia Fendleri N. E. Brown, sp. nov.

Stem climbing, the flowering parts with internodes 4.5–12 cm. long, 1–2 mm. thick, thinly puberulous with minute curved hairs on the youngest parts, becoming glabrous and brown with age. Leaves with petioles 6–15 mm. long and blades 5–10 cm. long and 3–7 cm. broad, elliptic, subequally and broadly rounded at both ends, with a small abrupt point 1–2 mm. long at the apex, with about 5 ascending curved primary veins on each side of the midrib, inarching at their tips and forming loops near the margin. Racemes axillary, the axis 1–2 cm. long in the example seen, bearing 15 or more flowers on the upper half, flowerless below, thinly and minutely puberulous. Bracts minute, less than 1 mm. long. Pedicels 12–15 mm. long, slender, puberulous. Sepals 5 mm. long and 1.5–2 mm. broad, lanceolate, acute, thinly puberulous. Corolla pubescent at the top of the tube inside, otherwise glabrous; tube 15–17 mm. long and about 4 mm. in diameter, cylindric, with the mouth, where the lobes pass from it, raised into an erect ring 1 mm. high; inside this ring arise 5 linear erect exserted processes (coronal-lobes) 4 mm. long; lobes

about 12 mm. long and 7 mm. broad, somewhat rhomboid, or obliquely subtruncate. Stamens inserted near the top of the tube, glabrous; filaments 2 mm. long; anthers sagittate, 4.5 mm. long, exserted. Ovary surrounded by an obtusely 5-lobed fleshy disk.

Trinidad, without precise locality, *Fendler 628*.

Cordia ierensis Britton, sp. nov.

A tree up to 10 m. high, with slender, finely appressed-pubescent twigs. Leaf-blades elliptic to ovate, thin, 2 dm. long or less, scabrate-puberulent, the apex abruptly acuminate, the base obliquely obtuse or narrowed, the petioles 2 cm. long or less; panicle about 8 cm. broad, broader than long, many-flowered, its branches slender, densely appressed-pubescent; flowers sessile, the buds obovoid, rounded, densely appressed-pubescent, about 2 mm. long.

Forests, Trinidad. Type from Morne Bleu (*Britton, Freeman and Bailey, 2277*). In bud March 13, 1921. This is, as determined by Mr. N. E. Brown at Kew, the *Cordia panicularis* of Grisebach, not of Rudge.

Aegiphila trinitensis Britton, sp. nov.

A shrub, with slender, glabrous branches, the bark nearly white, the young shoots brown, short, minutely puberulent. Leaves short-petioled, the blades ovate, thin, small for the genus, 4 cm. long or less, the apex acute or acuminate, the base narrowed; panicles small, short-peduncled, strigose, several-many-flowered, 2–3 cm. broad; calyx obconic, truncate, puberulent; corolla white, about 8 mm. long.

Hillsides and thickets in moist districts, Trinidad. Type from St. Ann's (*Mrs. W. E. Broadway*). In flower May 10, 1919. This is the species recorded by Grisebach from Trinidad, as *Aegiphila laevis*.

Anguria elliptica Britton, sp. nov.

A slender, glabrous, high-climbing vine, with very slender tendrils 15 cm. long or less. Petioles about 2 cm. long; leaf-blades simple, oblong-elliptic, thin, entire, about 8 cm. long, pinnately veined, the apex abruptly acute, the base obtuse; peduncles slender, longer than the leaves; staminate flowers scarlet, spicate; spikes about 3 cm. long; calyx-lobes subulate, 1 mm. long; corolla-lobes spatulate-obovate or obovate, 4 mm. long, 2–2.6 mm. broad, rounded or subtruncate and mucronate at the apex, the margin minutely ciliate; anthers 4.5 mm. long, straight.

Forests in wet or moist districts, Trinidad; type from Arima (*Britton 2084*). In flower March 4, 1921.

66. UNDESCRIBED SPECIES FROM PORTO RICO

Scleria doradoensis Britton, sp. nov.

Perennial? Culms slender, rather stiff, glabrous, erect, tufted, 3–4 dm. high. Leaves glabrous, scabrate, shorter than the culm, about 2 mm. wide, the apex attenuate; inflorescence terminal, glomerate-spicate, 5–7 cm. long; glomerules 6–8, few-flowered, not nodding; bracts about 3 mm. long, brown-ciliate; achene white, subglobose-obovoid, very obtusely trigonous, verrucose-tuberculate, 1.5 mm. long, 12-porose underneath just above the trigonous base; hypogynium none.

White sand near Dorado (*Britton, Britton and Brown 7064*).

Scleria Stevensiana Britton, sp. nov.

Perennial? rootstocks short or none; culms very slender, tufted, slightly scabrous above, weak, 4–5 dm. long. Leaves soft, scabrous-margined, 4 mm. wide or less, panicles 2 or 3, axillary, the lower stalked, the upper one nearly sessile, about 3 cm. long; bracts narrowly linear-subulate, 2.5 cm. long or less; spikelets several or numerous; achene depressed-globose, about 1.5 mm. in diameter, apiculate, glabrous, shining, faintly reticulated, nearly white, with 3 vertical brown bands; hypogynium lobes lanceolate, acuminate, glabrous.

Lares (*Stevens and Hess 4944*).

Lagenocarpus portoricensis Britton, sp. nov.

Culm stout, erect, trigonous, glabrous, about 8 dm. high. Leaves 8–12 mm. wide, nearly as long as the culm, smooth, long-attenuate, with numerous transverse veinlets; panicle narrow, puberulent, about 3 dm. long and 5 cm. thick, the lower half of staminate spikelets on nearly erect branches, the upper half of pistillate; bractlets aristate; staminate spikelets about 4 mm. long, short-stalked; scales subtending the achene obovate, subtruncate, ciliolate, mucronate; achene, with its beak, ovoid, 3 mm. long, brown with three darker blotches, the beak about as long as the body.

Wet sandy situations between Manati and Vega Baja (*Underwood and Griggs 946*, type); collected also by Sintenis near Dorado. Recorded by C. B. Clarke and by Urban as *L. tremulus* Nees.

Rynchospora Blauneri Britton, sp. nov.

Perennal by short rootstocks; culms filiform, weak, clustered, glabrous, 3–5 dm. long; leaves filiform, glabrous, shorter than the culms; spikelets narrowly oblong, 3 mm. long, few together in 2 or 3 distant compact clusters subtended by a filiform bract 3–5 cm. long; scales ovate-oblong, acute, light brown; bristles none; achene obovate, light brown with darker brown margins, smooth, about 1 mm. long; tubercle conic, acute, about one-third as long as the achene.

Sierra de Luquillo (*Blauner 247*, in herbarium of Columbia University, collected in 1852–53). Referred by Clarke to *R. divergens*.

Rynchospora luquillensis Britton, sp. nov.

Perennial by rootstocks; culms very slender, smooth, erect, about 2 dm. high. Leaves narrowly linear, about 1 mm. wide, flat, smooth, shorter than the culm; inflorescence a small terminal cluster of few spikelets; spikelets narrowly oblong, about 4 mm. long; scales oblong, brownish, acute; bristles about 6, retrorsely barbed, a little longer than the achene; style elongated; achene narrowly obovate, smooth, brown, about 2 mm. long; tubercle subulate, about as long as the achene.

Sierra de Luquillo (*Brother Hioram 364.*)

67. AN UNDESCRIBED SIPHOCAMPYLUS FROM HAYTI

Siphocampylus pinnatisectus Gleason, sp. nov.

Stem herbaceous, erect, slender, glabrous. Leaves alternate, broadly oblong in general outline, 5–7 cm. long, 3–3.5 cm. wide, narrowed at base into a petiole, glabrous, deeply pinnatisect into a terminal and 5–7 pairs of lateral linear lobes, each lobe and the rhachis about 2 mm. wide, with 2–4 sharp salient teeth or the smaller entire, sharply acute or submucronate, with a single midvein and faint lateral veinlets; flowers in the upper axils, few in number, appearing subcorymbose by the shortened internodes, on minutely puberulent pedicels 1 cm. long; hypanthium obconic, acute at base, 3 mm. high; calyx-lobes narrowly linear-triangular, acuminate, erect, separated by narrow acute sinuses; corolla red, about 25 mm. long, narrowly tubular, somewhat curved ventrally, constricted at base, gradually enlarged upward, 3 mm. in diameter at the throat, its lobes all depressed, 3–4 mm. long.

Type, *Nash and Taylor 1701*, collected on an open sunny hillside, between La Brande and Mt. Balance, Hayti, at altitude of 3150 ft., August 15, 1905.

Siphocampylus pinnatisectus differs from all other West Indian members of the genus in its deeply pinnatisect leaves.

INDEX TO AMERICAN BOTANICAL LITERATURE

1920–1922

The aim of this Index is to include all current botanical literature written by Americans, published in America, or based upon American material; the word America being used in the broadest sense.

Reviews, and papers that relate exclusively to foresty, agriculture, horticulture, manufactured products of vegetable origin, or laboratory methods are not included, and no attempt is made to index the literature of bacteriology. An occasional exception is made in favor of some paper appearing in an American periodical which is devoted wholly to botany. Reprints are not mentioned unless they differ from the original in some important particular. If users of the Index will call the attention of the editor to errors or omissions, their kindness will be appreciated.

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